Chapter 3

USFWS

Great egret looking for lunch along Back Bay shoreline

Refuge Resources

- Summary
- Physical Environment
- Biological Environment
- Socio-Economic Factors
- Archaeological and Historical Resources
- Refuge Management and Use

Summary

Back Bay National Wildlife Refuge is located in southeastern Virginia along the Atlantic Ocean and within the southern half of the city limits of Virginia Beach. The environment of this 9,035-acre Refuge consists mostly of water, barrier sand dunes, and wetland marsh. The immediate surrounding environment is residential, rural agriculture, barrier dunes, inland water, and ocean front. The area just north of the Refuge is urban.

Back Bay NWR was established by Executive Order #7907 on June 6, 1938. Prior to acquisition by the Federal government, the barrier beach portion was generally flat and sandy. The saline soils were unproductive. Periodic storms from the northeast (northeasters) and hurricanes pushed large quantities of sea water across these flat beaches, and into Back Bay. During the early 1930's the Civilian Conservation Corps built brush fences and planted cane and bulrush to catch moving sands; thus building and stabilizing new sand dune formations. Later, wooden sand fences were constructed, and many dunes were planted with Beachgrass (*Ammophila breviligulata*). These new dunes protected the bayside flats from oceanic waters and permitted formation of an oligohaline marsh, which is nearly free of salt particles.

The original 1938 Executive Order established Back Bay NWR *"….as a refuge and breeding ground for migratory birds and other wildlife."* Another of the Refuge's primary purposes (for lands acquired under the Migratory Bird Conservation Act) is *"… use as an inviolate sanctuary, or for any other management purpose, for migratory birds."* The Refuge is part of the eastern portion of the Atlantic Flyway. Waterfowl populations thus form one of the prime reasons for the existence of the area as a National Wildlife Refuge. Once known as a large haven for migratory birds, the past several decades have seen waterfowl populations and submerged aquatic vegetation (SAV) decline. Water quality, however, appears to have generally improved.

The latter half of the twentieth century saw rapid urban growth in the northern half of the City of Virginia Beach. The population of the city increased ten-fold to 425,000 in 2000. Future urban growth has the potential of presenting a major impact on the rural nature of land use surrounding the Refuge. The Refuge has doubled in size since the early 1990's, perhaps stemming additional growth surrounding the bay. This recent land acquisition also opens up the possibility for visitor facilities along the western border of the Refuge. Current visitor facilities are located in the northeast section of the Refuge, where there are more than 100,000 visits per year.

Wildlife diversity and quantity are affected by complex relationships, which are often difficult to grasp. Long term changes in water quality, as measured by suspended sediments and nitrates, have seemingly improved. On the other hand, wildlife, as measured by waterfowl and submerged aquatic vegetation, appears to have declined. Reasons for declining waterfowl populations may be due to local declines in SAV, shifts in the Atlantic Flyway out of the Back Bay region, and overall Atlantic Flyway declines in populations. An understanding of the affected environment notes these changes and helps point the direction to future management goals, both for Back Bay and for the National Wildlife Refuge System as a whole.

Physical Environment

Location

The City of Virginia Beach is in the southeastern corner of Virginia with the Atlantic Ocean to the east; Currituck County, North Carolina to the south; the cities of Chesapeake and Norfolk, Virginia to the west; and the Chesapeake Bay to the north. Land use patterns divide the City of Virginia Beach into three sections. The northern section is the higher density urban and residential region. The southern section is the rural region. The mid section or "Princess Anne Transitional Area" provides a mixed density transition between the urban north and rural south. The boundary between the urban north and Transition Area is known as the Green Line. Back Bay partially bisects the City from the south in an East-West direction, with North Landing River and Back Bay-associated bay complex comprising the primary water areas.

The 9,035 acre Refuge is located in the eastern half of the rural southern section of Virginia Beach. The Refuge is bounded to the east by the Atlantic Ocean, to the south by False Cape State Park and Back Bay, to the west by rural land, to the northwest by the mixed density Transitional Area, to the north by Lake Tecumseh, and to the northeast by the Sandbridge residential resort community.

Climate

The climate of Virginia Beach is modified continental with mild winters and hot, humid summers. The average temperature in winter is 42° F and the average daily minimum temperature is 33° F. In summer, the average temperature is 77° F, and the average daily maximum temperature is 85° F. Annual precipitation averages 45 inches. The growing season is 237 frost-free days, the longest growing season in Virginia. The average seasonal snowfall is 7.2 inches. The average relative humidity in mid-afternoon is approximately 58%. Humidity is higher at night, and the average at dawn is about 78%.

The prevailing wind direction from March through October is from the southwest. Average wind speed is highest in March at 10.6 miles per hour. The prevailing wind direction from November through February is from the northwest. The area is frequently subject to storms out of the northeast during fall, winter, and spring. These storms can produce localized flooding and severe shoreline erosion. The summer in Virginia Beach produces numerous thunderstorms whose strong winds and heavy rains sometimes result in localized flooding. Although Virginia Beach is north of the track usually followed by hurricanes and tropical storms, the city has been struck infrequently by hurricanes.

Wind direction and time of year have a significant impact on the bay within Back Bay NWR. Back Bay is too far north of Currituck Sound to be affected by lunar tides. However, wind tides normally produce a decrease in average mean water level during the winter due to the northwest winds that push its waters southward. The opposite occurs during the rest of the year as mean water level increases due to southwest winds pushing the water northward.

Topography

The flatness of the lands surrounding Back Bay is the central topographic characteristic of the watershed. Pungo Ridge, along which Princess Anne Road runs to the west, has the highest land elevation on the west side of the Bay, reaching 15 to 20 feet above mean sea level (msl) at several points. On the eastern boundary of the Bay, the sand dunes of False Cape present a second ridge of higher elevation, reaching 50 feet msl or greater at a number of locations and 64 feet at the highest. These two parallel ridges trend in a north-south direction.

In between these parallel ridges, on the western Pungo side, lie the better drained uplands. These uplands fall away from the highest elevations to about

five feet msl. This lower elevation is the upper edge of the flood plain. This is where the principal marshes and swamps of the Bay's edge are found. However, throughout the flood plain at its higher elevations and where the soils are inclined to dry out more readily, crops are farmed. Due to the universal flatness and low elevation of the land, flooding from high wind tides is a frequent problem for the farmers, particularly below the three- or four-foot contour levels.

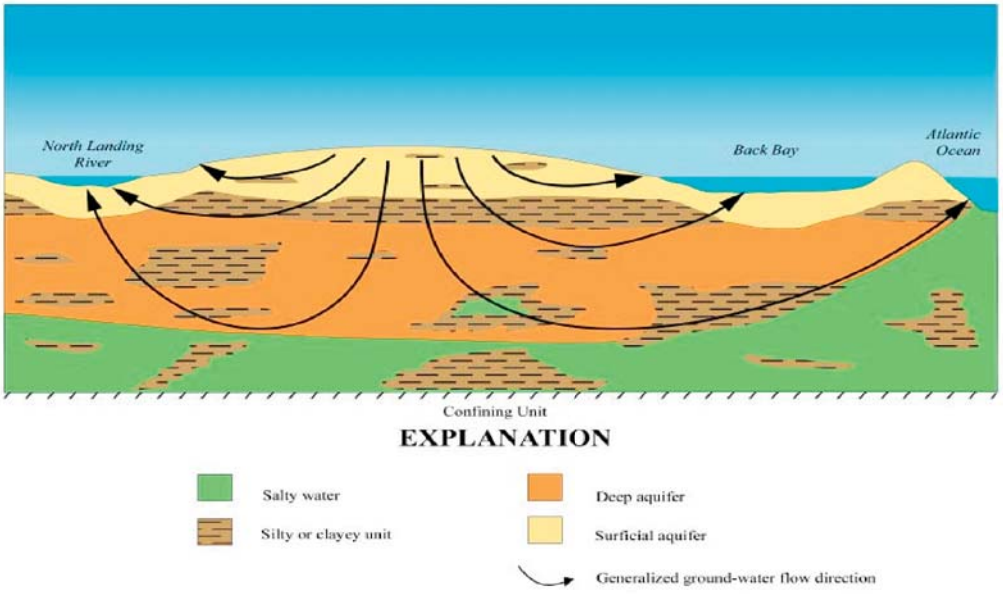
Geology and Groundwater

Roy Mann Associates, Inc. (1984) described the Back Bay area as follows:

> *"Virginia Beach lies within the Atlantic Coastal Plain Physiographic Province. The physiography of the area is typical of that of most of the Atlantic seaboard and consists of gently sloping terrace plains extending seaward from the base of the Appalachian Mountains."*

The entire wedge of coastal plain sediments is composed of stream-carried sands and clays deposited along a shoreline and nearshore environment not dissimilar to that which presently exists in the area. These include beach and dune environments, sand marshes, stream channels and floor deposits. The source of the sands and clays was primarily the down wasting of the eastern seaboard continental land mass. Six stratigraphic units compose the 4,000 feet of unconsolidated sediments of the Coastal Plain in the Virginia Beach and Back Bay region. The uppermost unit, the Columbia Group, is characterized by light colored clays, silts, and sands of recent and Pleistocene Age (2.5 mybp to present). These deposits range between 20 and 50 feet thick and include recent dune, beach, and river sediments.

Figure 3.1. East-west cross-section through southern Virginia Beach (Johnson 1999)



Two primary freshwater aquifers exist in the Back Bay watershed (Roy Mann Associates, Inc. 1984). They are the confined aquifers within the Yorktown formation, and the shallower, unconfined aquifer within the overlying Columbia deposits. Municipal wells are generally within the confined aquifer, while many domestic wells are within the unconfined aquifer (Figure 3.1).

All major groundwater quality criteria, with minor exceptions, have been found to be within applicable concentration standards. Salt water intrusion has been found in deeper groundwater supplies. A small increase in overall nitrate concentrations in groundwater is evident and suggests the impact of agricultural activities. However, for the most part, nitrate concentrations in the shallow regional aquifer are low in comparison with other agricultural areas. In general, groundwater quality in the Back Bay watershed is good.

Soils

The U.S. Department of Agriculture's Soil Conservation Service mapped the soils within the City of Virginia Beach during 1981-1982. The major associations which are found within the Refuge and study area include Acredale-Tomotley-Nimmo, Back Bay-Nanney, and Newhan-Duckston-Corolla. The following descriptions of these associations are taken from the resulting USDA publication, "Soil Survey of City of Virginia Beach, Virginia" (September 1985).

Acredale-Tomotley-Nimmo Association — This association consists of nearly level soils in broad, flat areas of the study area. The Acredale soils are slowly permeable; Tomotley and Nimmo soils are moderately permeable. This association is used mostly for cultivated crops, but some areas are in woodland or are used for community development. Much of this association has been cleared and drained; the drained areas have good suitability for cultivated crops. The main limitation for community development is a seasonal high water table.

Backbay-Nanney Association — This association is primarily found in the marshes and swamps of the study area and Refuge. This soil consists of nearly level, frequently flooded soils on the flood plains of Back Bay and its tributaries. Slopes range from 0 to 1 %. The Backbay soils occur in broad, flat marshes, while the Nanney soils occur in wooded drainage ways and on flood plains. This association has little suitability for most uses other than as wetland wildlife habitat and for woodland. Flooding is the main limitation for use of this soil.

Newhan-Duckston-Corolla Association — This association consists of nearly level to steep, very rapidly permeable soils on grass- and shrub-covered sand dunes, flats, and depressions along the ocean. The Newhan soils are on undulating to steep coastal dunes and are excessively drained; Duckston soils are on nearly level flats and in shallow depressions between coastal dunes and are poorly drained and/or flooded in some areas after heavy rainfall and by overwash by salt water; Corolla soils are on low, undulating coastal dunes and on flats and are somewhat poorly drained to moderately well drained. Most areas of this association are covered by salt-tolerant grasses and shrubs. The major limitations of this association for community development are a seasonal high water table, the very rigid permeability, slope, and the instability of sparsely vegetated areas.

Surface Waters and Wetlands

The Refuge roughly includes the northern two-thirds of the 39 square mile Back Bay complex. This complex is divided by its natural configuration of islands, into five smaller bays: North, Shipps, Redhead, Sand and Back Bays. Numerous channels, narrows, and guts link these bays together, as does sheet-flow across wetlands during high-water events. The surrounding uplands and wetlands cover an additional 64 to 65 square miles. Major drainages into the bay include (from northwest to southwest) Hell Point, Muddy, Beggar's Bridge, Nanney and Devil Creeks. The surrounding lands drain into these five creeks and/or the bay, via numerous connected drainage ditches, and constitute the Back Bay flood plain.

Most of the bay is shallow with an average depth of less than 5 feet. The bay maintains fresh to slightly brackish (0 to 4 parts per thousand ppt salinity) water, with salinity increasing slightly as one proceeds southward. Back Bay has been defined as an oligohaline estuary (Norman 1990). There is no lunar tidal influence because the nearest Atlantic Ocean inlet is 60 miles south of the Refuge. Water level fluctuations are principally wind-generated (wind tide); with sustained southerly winds, generally during summer, moving bay waters to the north and raising the northern bay levels. Sustained northerly winds, generally during winter, move bay waters to the south and decrease mean water levels in the northern Bay areas. During strong wind tides, from the south, the water in flood plain areas will rise 3 to 4 feet, and flood low-lying areas (below the 3- 4 feet contour levels) along Muddy Creek, Nanney Creek and Sandbridge Roads. Roy Mann Associates, Inc. (1984) reports that water circulation in Back Bay is dynamic, where daily fluctuations in water level due to wind alone in excess of 0.75 feet are common. The effect of wind tides on Back Bay is of sufficient strength to enhance the mixing of water from tributaries with adjacent bay water.

Open water, including Back Bay, comprises the most abundant wetlands community type on the Refuge. According to Roy Mann Associates, Inc. (1984) approximately 22% of the Back Bay watershed was wetlands. Emergent wetland vegetation comprised 11,351 acres or 17% of the watershed. Lowland forest with 2,357 acres and scrub-shrub wetlands with 749 acres comprised 4% and 1%, respectively, of the watershed. Much of this vegetation was characterized by relatively homogeneous stands of cattails, and black needlerush.

The 900-acre Refuge freshwater impoundment complex is located on the barrier island portion of the Refuge, south of the headquarters. This ten-impoundment complex consists principally of eight moist soil management units that are flooded in the fall and winter and drawn-down in the spring and summer. Two of the impoundments serve as water reservoirs that hold water as needed, regardless of the season. Water is supplied to this complex by a pair of large pumps that can transport approximately 15,000 gallons per minute from the Bay adjacent to the West Dike, into the C-storage Pool reservoir; from where it is distributed into the desired impoundment via interconnecting water control structures.

Water Quality

Beginning in 1972, and particularly since 1986 onward, the Virginia Department of Environmental Quality has kept extensive surface water quality records on at least ten monitoring sites within or immediately surrounding Back Bay NWR and its tributaries. Samples are collected every one to three months. Data analyzed for this CCP include: salinity, dissolved oxygen, nitrate, pH, temperature, fecal coliform, turbidity (secchi disc; total suspended solids), and phosphorus. Preliminary analysis of a number of water quality parameters indicate generally stable or improving water quality since the mid-1980's, for some specific elements. This may reflect better agricultural and construction practices and a cessation of a period of high suburban growth in the Sandbridge area (personal communication, Mel Atkinson).

For example, one of the water quality sites is located within the bay between Ragged Island and Wash Flats (Station: 5BBKY006.48). This is an excellent open bay site to monitor bay-wide, long-term changes in water quality. Figures 3.2 and 3.3 indicate improving water quality with respect to Total Suspended Solids (TSS) and Nitrates. These TSS and Nitrate improving trends are seen at other monitoring sites as well.

Figure 3.2. Total suspended solids between Ragged Island and Wash Flats from 1986-2003

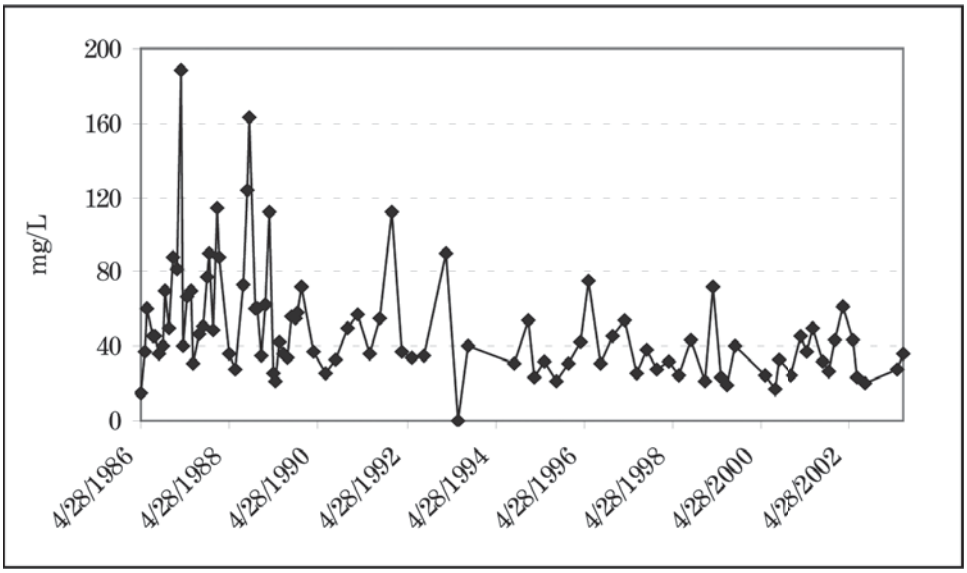
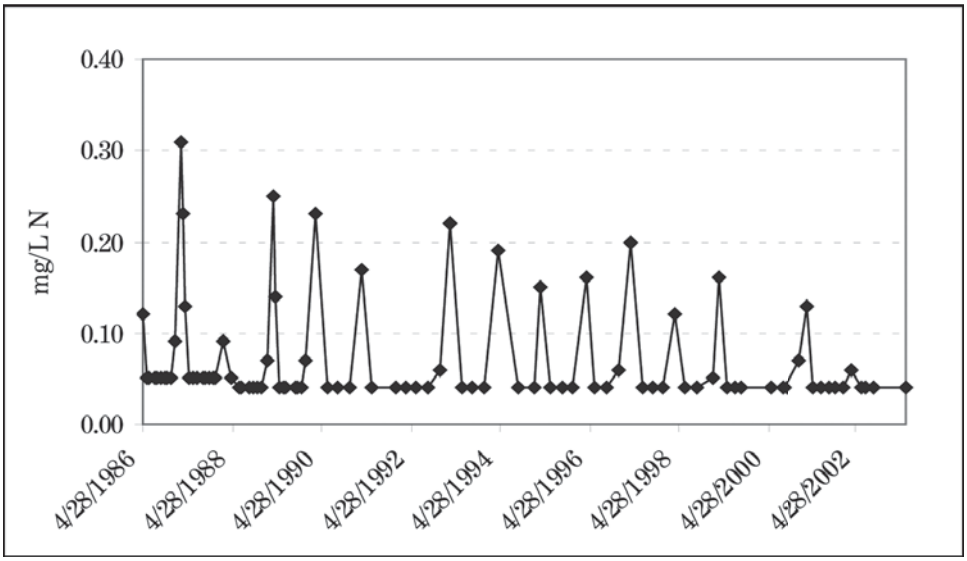


Figure 3.3. Total Nitrate between Ragged Island and Wash Flats from 1986-2003



TSS are solids in water that can be trapped by a paper filter. TSS can include a wide variety of material, such as silt, decaying plant and animal matter, industrial wastes, and sewage. High concentrations of suspended solids can cause many problems for aquatic life.

High TSS can block light from reaching submerged vegetation. As the amount of light passing through the water is reduced, photosynthesis slows down. Reduced rates of photosynthesis causes less dissolved oxygen to be released into the water by plants. If light is completely blocked from bottom dwelling plants, the plants will stop producing oxygen and will die.

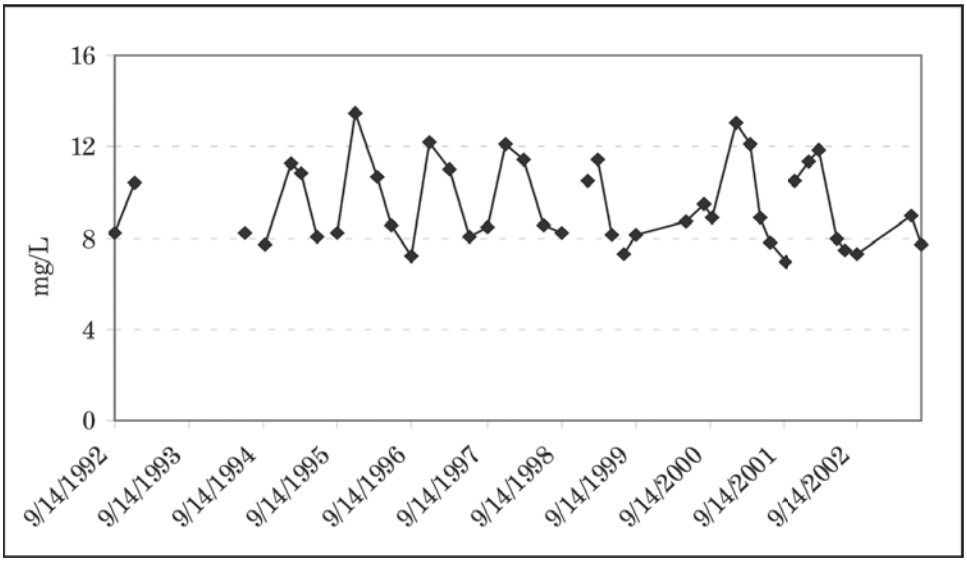
Nitrates and nitrites are nitrogen-oxygen chemical units, which combine with various organic and inorganic compounds. The greatest use of nitrates is as a fertilizer. Most nitrogenous materials in natural waters tend to be converted to nitrate, so all sources of combined nitrogen, particularly organic nitrogen and

ammonia, should be considered as potential nitrate sources. Primary sources of organic nitrates include human sewage and livestock manure, especially from feedlots. The federal drinking water standard is 10 milligrams per liter (mg/l) nitrate-nitrogen (NO_3-N). All stations appear to have nitrate readings within federal drinking water standards.

Standards for pH in Virginia waters are in the range of 6 to 9. Several of the stations had occasional readings above 9, indicating water that is alkaline. The general trend over time has been from slightly alkaline to more neutral water. The standard for surface water temperature is a maximum of 31 degrees Centigrade. Several of the Back Bay tributaries had occasional summer readings slightly above the standard.

Dissolved oxygen is the amount of oxygen dissolved in water, measured in milligrams per liter (mg/L). This component in water is critical to the survival of various aquatic life. Virginia has set a minimum of 4.0 mg/L for dissolved oxygen. Nanney Creek and Beggars Bridge Creek had occasional readings which fell below this standard (Figure 3.4). The rest of the stations had consistent readings above the standard.

Figure 3.4. Dissolved oxygen levels between Ragged Island and Wash Flats,1992-2003



Salinity is the total of all salts dissolved in the water, measured in parts per thousand (ppt). Since 1987, salinity levels have varied. They occur as spikes of increased salinity. These spikes (1987, 1995, 2002) are in the 3 to 5 ppt range (oligohaline) and are within ranges found throughout Currituck Sound (Figure 3.5). Periods of lower salinity (1 ppt. or less) have occurred in Back Bay, and represent water fresher than that found in Currituck Sound.

Since 1991, biweekly water quality sampling at the Refuge headquarters dock revealed that as stream flow input and precipitation levels increased, bay salinity levels generally declined (0 to 2 ppt.). When stream flow input and precipitation levels decreased, bay salinity levels increased (3- 4 ppt.). Salinity is usually regulated by how far north the effects of brackish waters from Albemarle and Currituck Sounds in North Carolina reach. Back Bay's nearest ocean outlet is approximately 60 miles to the south, at Oregon Inlet, NC. So, stream flow regimes and precipitation help regulate this brackish-fresh water interface.

Roy Mann Associates, Inc. (1984) states, "Water quality data for Back Bay indicate a strong phosphorous limitation in the open waters and many of the

tributaries. Therefore if environmental controls are to be established, they should be broad enough that the loading with phosphorous is curtailed as well as limitations being effected on nitrogen and other minerals."

Figure 3.5. Salinity levels between Ragged Island and Wash Flats, 1994-2003

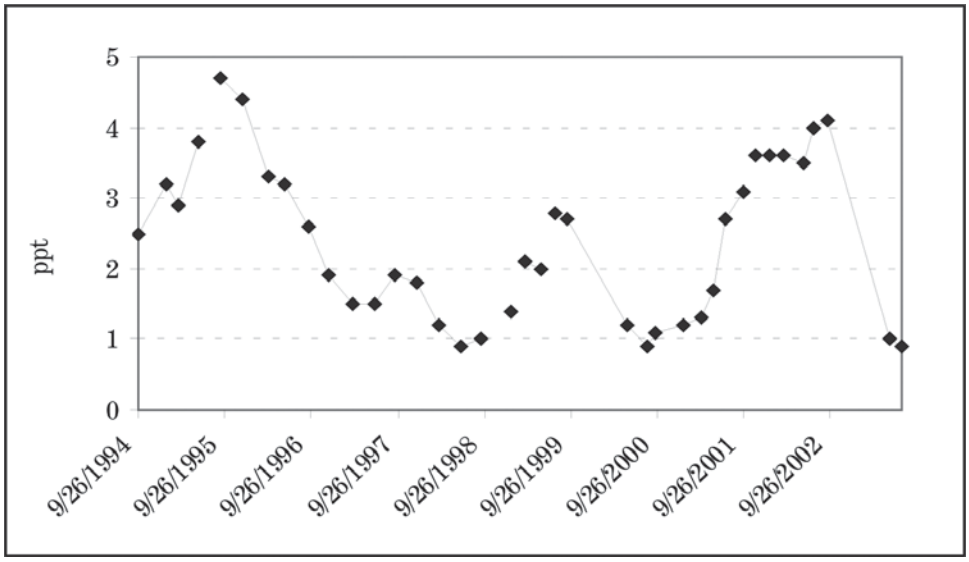
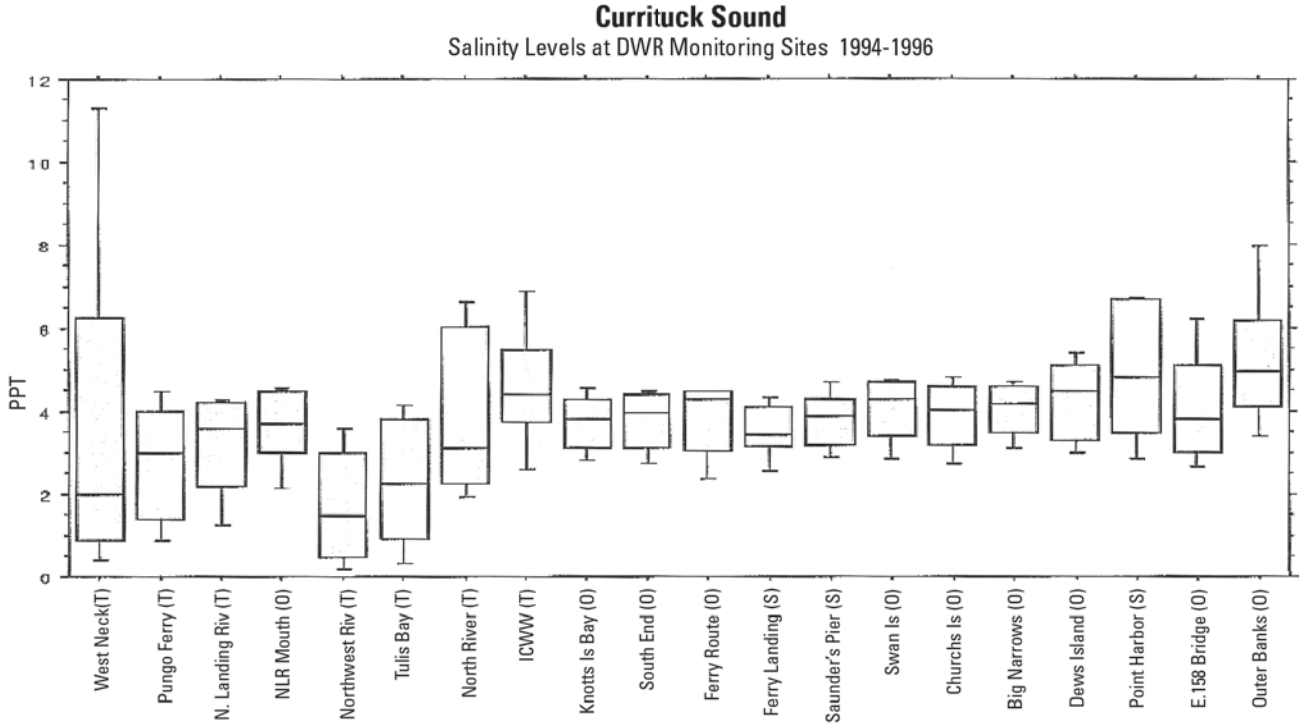


Figure 3.6. Box plots of salinity data recorded by the Division of Water Resources at several stations in Currituck Sound—1994 through 1996. (T = tributary station; O = open water station; and S = shore station) (North Carolina Department of Environment and Natural Resources 1997)



In summary, many improvements in Back Bay's water quality have been occurring. They may be partially attributable to the elimination of the large number of septic systems in Sandbridge following construction of a new city sewer line in the mid 1990s; improvements in local agricultural and hog farming practices; and a reduction in the amount of land use disturbances in the watershed from previous large housing developments (i.e., Lago Mar, Red Mill, Ocean Lakes).

Concerns over the loss of submerged aquatic vegetation (SAV) during the past twenty years have usually been blamed solely on negative impacts to Back Bay's water quality; however, existing water quality data does not appear to support significant water quality degradation. The infrequency of previously referenced water quality data collection (once every three months) presents the possibility of missed spikes or peaks in nutrients, silt, or other pollutant discharges into the watershed. A closer analysis of specific water quality parameters critical to the health and well-being of SAV beds needs to be conducted at the most critical times of year to better understand this complex issue. It is believed that SAV beds both absorb nutrients and reduce turbidity by their presence, as well as serving as a buffer to wave action that reduces erosion of bay and island shorelines. The islands and shorelines of Back Bay have manifested rapid erosion rates during the past 20 years, so that the existing shorelines no longer resemble the most recent United States Geological Survey (USGS) topographic maps.

Fire

Potential Wildfire Hazard. Virginia's wildfire season is normally in March and April and again in October and November. At these times the relative humidity is usually low, winds tend to be high, and fuels are cured to the point where they readily ignite. Fire activity fluctuates not only from month to month, but from year to year. During years when Virginia receives adequate precipitation, wildfire occurrence is low. During low precipitation, wildfire occurrence is high, particularly during periods of warm, dry, windy weather.

Most local wildfires occur outside the normal fire seasons and are thought to be human-caused. There are very few lightning-caused fires. Refuge records show most local wildfires occur during the late winter waterfowl hunting season in late January through early March. These burns create open marsh habitat that attracts snow geese and other waterfowl. Both waxmyrtle and black needlerush are volatile and burn well while green.

All unplanned wildfires are suppressed, where possible, in a safe, and cost-effective manner, with minimum damage to wildlife and private property resources through use of appropriate management strategies.

Efforts are underway to construct and maintain adequate wildland urban interface (WUI) fire-breaks inside Refuge boundaries to protect adjacent private properties in Sandbridge and several bordering roadways (ie. Muddy Creek, Sandbridge, Colechester, New Bridge Roads). Those WUI fire-break construction efforts will continue until the threat of wildfire to private residences, and to Refuge natural habitats, is greatly reduced or eliminated.

Role of Fire in the Ecosystem. A combination of fire types, including naturally occurring (lightning-caused) fires (Kirwan and Shugart 2000), and fires associated with Native American and European colonists' (Patterson and Sassman 1988) activities, have historically influenced vegetation in the eastern United States. Naturally occurring fire is infrequent in the mid-Atlantic; however, human-set fire has historically, and dramatically impacted the ecology of the region, including coastal Virginia (Brown 2000). Many open areas have

been created by slash-and-burn agricultural practices of Native Americans and from the harvesting and gathering of firewood (Brown 2000).

Frost (1995) portrays the Back Bay vicinity of southeastern Virginia to be a wetland area that maintained a presettlement fire regime, or frequency of 4-6 years, with most marsh fires probably igniting from fire moving through vegetation on adjacent uplands, with the original fire igniting from a lightning strike. Frost (1995) goes on further to state that, "successive reduction in fire frequency, as has occurred throughout the South, leads to dominance of oligohaline marshes by a few tall marsh species and *Juncus roemerianus*." Losses of wetland plant species richness, including such rare fire-dependent types as the spikerush and eryngo, subsequently have occurred.

Bratton and Davison (1986) found historical evidence of fire in maritime forests of Cape Hatteras, North Carolina. The authors concluded that fire suppression, in combination with other disturbances, increased pine species, decreased oak species, and shifted fire regimes from small, frequent, low-intensity fires, to infrequent, larger, high-intensity fires. The authors also concluded that fuel management would be necessary to restore the site to oak dominance, its pre-settlement condition. Back Bay NWR, immediately to the north, has a similar situation in effect that should lead to new evaluations of fuel-loading, loblolly pine invasion, and live oak perpetuation in its maritime and bottomland forests.

The bird nesting season creates a need to avoid burning during the last week of March through June of each year, if possible. Therefore, the Refuge prescribed fire season normally runs from September through November, or March if necessary.

Discussions with longtime local residents reveal that the local populace has historically burned off black needlerush marshes in late fall and winter, in the belief that it improves the marshes for wintering waterfowl use. After careful consideration and research, we have concluded that prescribed burning of Back Bay NWR needlerush and saltmeadow hay marshes should be encouraged in the future. Objectives of prescribed fire include 1) Protect life and property; 2) Perpetuate the migratory bird resource; 3) Preserve native wetland biotic communities in their natural states; 4) Maintain maximum habitat diversity for the benefit of wildlife; 5) Protect, restore, and maintain endangered and threatened species and their habitats; 6) Implement a safe and cost-effective program of resource protection and enhancement; and 7) Reduce hazardous fuels. When carried out wisely, in 3-4 year cycles, the following habitat and wildlife benefits are realized:

a. Reduction of fuel-loading, especially matted needlerush stems among live plants and on marsh substrate. Fuel-loading also stifles germination of beneficial food-plants.

b. Increased use by wintering and migrating waterfowl (ducks, geese and tundra swans) of marsh areas, after the long, needle-tipped stems are removed.

c. Increased germination of desirable, herbaceous waterbird food-plants already in the seed-bank, by increasing sunlight penetration to marsh soils.

d. Rapid recycling of nutrients into the soil and remaining plant rootstocks.

Prescribed burning objectives during the 1990s and later have revolved around control of the invasive pest, Common, or Phragmites reed *(Phragmites australis)*. Prescribed burning has been used to remove the dense dead stands

of reeds that continue to stand for several years after dying. By continuing to shade the ground, these dead stands reduce or eliminate germination of more desirable annual food plants. By burning the dead stands, the shading ground cover and seed source is removed. Once the sun consistently reaches the ground, germination and production of more desirable plants occurs, from within the existing, diverse seed bank.

The only known exception to this needlerush prescribed burning recommendation, is in the western North Bay Marshes vicinity, where mixed needlerush and Phragmites reed marsh supports a breeding population of the Least bittern. The Least bittern is a "Species of Special Concern" in the state of Virginia. Removal of this unique habitat type's low-canopy platforms, created by lodge-poled reeds resting atop needlerush tips could result in a local decline of nesting and resting least bitterns.

In addition, the active bald eagle nest site on the woods edge of western North Bay Marshes, should also be protected from fire, especially during their December–May breeding season. This site is a priority protection area during a North Bay Marshes prescribed burn or a wild fire.

Within the impoundment complex, the eastern one-third of A, B and C Pools, and most of G, H and J Pools, are critical fall-winter fire protection areas. These moist soil units comprise much of the late winter food supply for wintering and migrating waterfowl. They are also priority protection areas during prescribed burns or a wildfire.

The Roanoke-Tar-Neuse-Cape Fear Ecosystem (RTNCF) Refuges Biological Review of 2000 (USFWS 2002) recommended an increased use of prescribed fire in future habitats management efforts.

Air and Noise

The U.S. EPA has set national air quality standards for six common pollutants, including ozone. Ground-level ozone, the main ingredient of smog, is a colorless gas formed by the reaction of sunlight with vehicle emissions, gasoline fumes, solvent vapors, and power plant and industrial emissions. Three ozone stations are located in the Hampton Roads region (Virginia Department of Environmental Quality 2005). Ozone data from 1990 to 2002 indicate that the number of times when air quality monitors have recorded ozone concentrations greater than 84 parts per billion, (the health-based air quality standard measured over eight hours), appears to be increasing from an average of four to seven times a year. For the three year period 2000 to 2002, and again in 2003, EPA classified the Hampton Roads region, including Virginia Beach as an 8-hour ozone non-attainment area (Figure 3.7). In prior years the region was a non-attainment area for the previously used 1-hour standard. By 2007, Virginia will submit a plan to reduce the level of ozone in non-attainment areas.

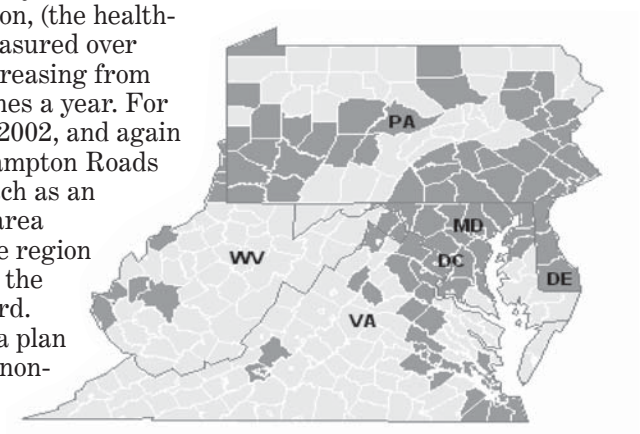
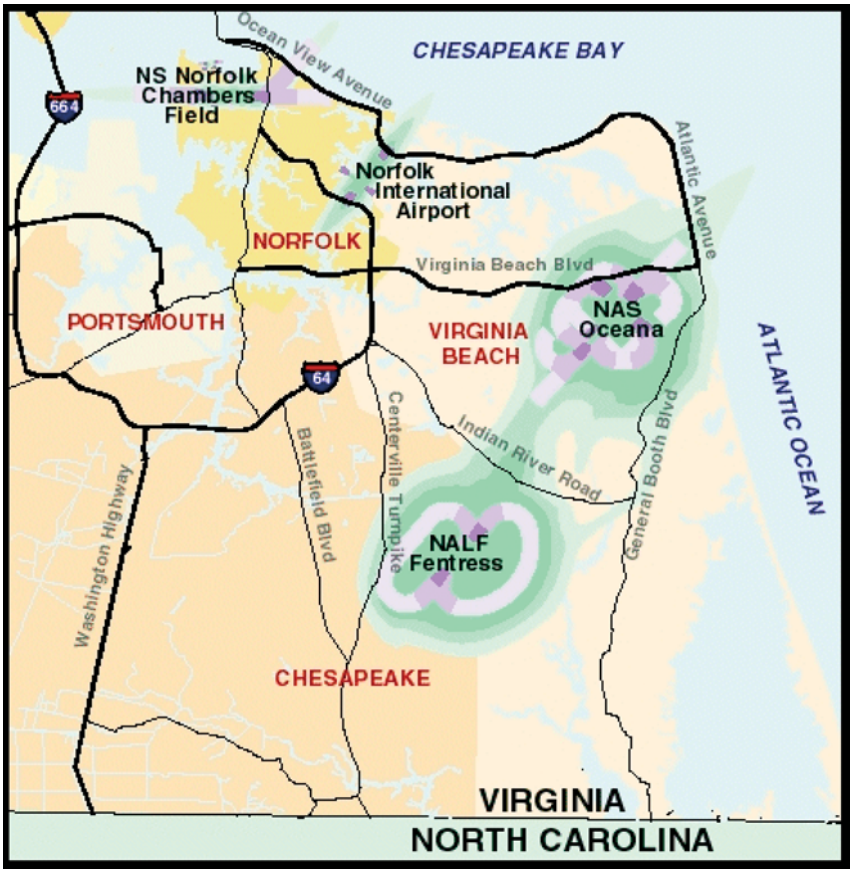


Figure 3.7. Mid-Atlantic Ozone Non-attainment Areas (Source: EPA 2003)

Local air quality concerns at the Refuge revolve primarily around smoke generated by prescribed fire burns, such as the fire break between the Refuge and Sandbridge community. Back Bay NWR contains vegetation and habitats capable of sustaining wildland fire, thereby requiring a fire management plan. Fires are timed as to create the least impact on the surrounding community.

Virginia Beach has a military base, Oceana Naval Air Station, for F-14 Tomcats and F/A-18-Hornet Squadrons. Noise levels can be excessively high just north and west of Back Bay NWR in areas surrounding Oceana (Virginia Beach) and Fentress Air Field (Chesapeake). The City's 2003 high noise zone map (AICUZ) locates Back Bay NWR within the least impacted area, with average noise levels less that 65 decibel dB (Figure 3.8). The military has cooperated in not conducting low altitude flights over the Refuge.

Figure 3.8. High Noise Zones within the Virginia Beach region.
(http://www.nasoceana.navy.mil/aicuz/)



Visual Resources

The expanses of visual natural resources that characterize the Refuge are of immeasurable value. The diversity of habitats, such as the beaches, dunes, bays, streams, swamps, woodlands, farmland, extensive marshes and islands all contribute to the scenic quality of Back Bay. Two of the most striking visual assets of the Refuge are the long, unbroken beach/dune vista and the extensive

marshes. The visual resources have gained increasing importance over the decades as development continues to occur on similar, previously unspoiled coastal barrier islands along the East Coast of the United States. The Refuge now provides a vivid visual contrast to developed areas located just north and west of the Refuge boundary.

From the dune ridges, vistas span from the ocean to the marsh, giving the area a sense of ecosystem continuity. The extensive marshes give way to forested swamp, woodlands, and farmland to the north and west. The diversity and distribution of fauna and flora along this section of barrier island and its associated Bay marshes are both interesting and complex, and contribute significantly to the Refuge's visual quality.

Although much of the landscape within the Refuge has been altered by man, some of these modifications, such as dune building and impoundment construction, have been effectively blended with the surrounding terrain. The constructed dune line, trail system and dike roads offer controlled public access to relatively undisturbed oceanfront, bay shoreline, wetlands, and upland forest. Such access provides an increasingly urban population the opportunity for unparalleled wildlife viewing, photography, nature study, environmental education, solitude and other visuals-related experiences that can rarely be found in urban environments.

Contaminants

As stated earlier, Back Bay itself is divided into five smaller bays: North, Shipps, Redhead, Sand and Back Bay proper. However, there are significant waterways which feed Back Bay that could transport contaminants to Back Bay. Those water-bodies are Hell Point Creek, Asheville Creek, Beggars Bridge Creek, Muddy Creek, Nanney Creek, and Scopus Marsh Creek.

Minor contaminant issues are identified and dealt with prior to acquisition. Species of concern to the Refuge includes migratory and resident waterfowl, nesting sea turtles, bald eagles and other migratory birds, fishes and all their appropriate habitats. Contaminant threats to these resources can be assessed as follows:

- potential spills from vehicular accidents on Princess Anne or Sandbridge Roads;
- spills along the Atlantic Coast from shipping traffic, which could present significant threat and depend on currents, tides, wind conditions, contaminant and proximity to the coast;
- spills from properties and small roadways along any of the watersheds that feed Back Bay; and,
- chronic problems associated with growing suburban sprawl including residential uses and abuses of pesticides, insecticides and fertilizers.

Acquisitions and protection by the Service and other agencies or non-profit conservation organizations serve to protect the smaller watersheds and Back Bay, and provide a buffer for lower levels of pollution associated with residential and light commercial uses; such buffering can also result in improved water quality in Back Bay.

Biological Environment—Vegetation

Vegetation Types

A large variety of vegetation types exist in and around Back Bay NWR. They can be classified in various ways, including uplands and wetlands (Map 3-1, table 3.1).

Table 3.1. Back Bay NWR General Habitats & Vegetation Communities*

General Habitat	Vegetation Community(ies)*	Dominant Species	Comments
Mixed Wooded Wetland	Non-Riverine Wet Hardwood Forest	Loblolly pine, Pond pine, Tupelo spp., Inkberry, Waxmyrtle & 2-3 ferns.	Saturated soils. Giant cane & Greenbriers are often present.
Deciduous Wooded Wetland Mixed w/Marsh	Estuarine Fringe Swamp Forest	Bald cypress, Swamp tupelo, Loblolly pine, Sweetbay, Redbay, Waxmyrtle & Royal fern.	Subject to irregular wind-tidal flooding.
Maritime Wooded Swamp	1) Maritime Swamp Forest 2) Estuarine Fringe Swamp Forest	1) Red maple, Sweetgum, Black gum/tupelo, Black willow, Sweetbay, Blue-berry, Waxmyrtle, Redbay, VA. Chain fern. 2) Bald cypress, Swamp tupelo, Loblolly pine, Sweetbay, Redbay, Waxmyrtle & Royal fern.	Seasonally flooded and/ or saturated soils, with hummock & hollow microtopography.
Shrub-scrub Wetland	1) Maritime Mixed Forest, 2) Maritime Shrub Swamp	1) Loblolly pine, Water oak, So. Red oak, Black cherry, American holly, Greenbrier, Blueberry, grape, ferns. 2) Waxmyrtle, Inkberry, Blueberry, Poison ivy, ferns.	Often on leeward slopes of dunes; Usually holds freshwater through most of year.
Maritime Upland Woodland	1) Maritime Loblolly Pine Forest 2) Maritime Evergreen Forest	1) Loblolly pine, Red maple, Black cherry, Waxmyrtle, Blueberry. 2) Live Oak, Loblolly pine, Laurel oak, Black cherry, Am.Holly, Devilwood, blueberry, Jessamine.	Ground/herbaceous cover sparse.
Upland Mixed Woodland	1) Non-Riverine Pine-Hardwood Forest 2) Non-Riverine Wet Hardwood Forest	1) Loblolly pine, Red maple, Sweetgum, Pond pine, Sweetbay, Black tupelo, Red bay, Dog-hobble, Cane. 2) 6 Oak species, Hornbeam, Holly, blueberry, Dog-hobble, Cane, Chain-fern, sedges.	Flat seasonally perched water tables, with shallow depressions that hold water intermittently.
Reforestation Area	White Cedar, or Bald Cypress and oak spp.	White cedar, or Bald cypress, oaks & tupelos.	Manually planted in former agricultural fields.
Agriculture	Row Crops	Soybeans & corn	Tended to by local Refuge cooperative farmers, & private farmers.
Old Field	Mowed grasses; or Forbs, shrubs & saplings	Switchgrass, Goldenrod, Waxmyrtle, High Tide Bush & Loblolly pine, Red Maple, Sweetgum saplings	Refuge old fields are bush-hogged at least once every two years.

General Habitat	Vegetation Community(ies)*	Dominant Species	Comments
Dune Swale Wetland	1) Maritime Wet Grassland 2) Interdune Ponds	1) Saltmeadow cordgrass, rushes, sedges, goldenrod, asters, sundew, etc. 2) Bulrushes, grasses, spikerushes, cattail, Rose-mallow, Water hyssop	1) Graminoid dominated wetlands in dune swales. 2) Semiperm. flooded, herbaceous swales; ologohaline ponds.
Dune Grassland	1) Maritime Dune Grassland 2) Beach-Dune Grasslands	1) Am. Beachgrass, Sea oats, Seaside goldenrod, Evening primrose, Seaside spurge, Purple lovegrass, Sandbur, Saltmeadow cordgrass, Purple sandgrass 2) Beachgrass, Sea rocket	1) Ocean/bay-front dunes influenced by storm surges 2) Ocean-front beach from wrack-line to toe of dunes; sparsely vegetated
Back-dune Grassland	Maritime Dune Grassland	Am. Beachgrass, Sea oats, Seaside goldenrod, Evening primrose, Seaside spurge, Purple lovegrass, Sandbur, Saltmeadow	Shrublands along ocean-front dune, inland edges. Trees & shrubs often stunted.
Fresh-water Impoundment	1) Moist-soil units 2) Emergent Marsh** 3) Maritime Swamp Forest 4) Maritime Wet Grassland 5) Interdune Ponds	1) Eastern, higher elevation areas with high annual plant production (Beggars ticks, Water hyssop, spikerushes, smartweeds, wild millets, flat-sedges) 2) Black needlerush, arrowheads, Water lilies, 4 SAV species, Narrow-lvd. cattail, Pickerelweed, Am. lotus, spikerushes	880 acres of ten, intensively managed, man-made wetlands units; surrounded by earthen dikes to contain water at desired levels
Emergent Marsh	Wind-Tidal Oligohaline Marshes	Black needlerush, Narrow-lvd. cattail, Big cordgrass, Saltmeadow cordgrass, Rose mallow, Olney three-square, spikerushes, Dotted smartweed, Canada rush, Pickerelweed	Natural herbaceous wetlands of bayshore and island areas with no ocean tidal influence
Open Water	Submerged Aquatic Vegetation (SAV)	Several pondweed species, Coontail, Wild celery, milfoils, Widgeongrass, Muskgrass, Southern naiad	Most Bay waters are currently lacking SAV; except for several sheltered coves.

*(*from CCP Vegetation Community Types)*

*** The term is used loosely in this context to refer to a managed habitat that demonstrates many of the characteristics of an emergent marsh. Nonetheless, because emergent marshlands in their unaltered state are so prevalent in this region, the term is used as a General Habitat heading as well.*

In using this table as a reference, please note that a number of habitat types are seen in more than one location. This crossover of community classes is a result of nature responding similarly to similar conditions, the most telling of which are weather (determined by the wind-tidal system) and proximity to the ocean. It is for this reason that overlap exists, for some habitats cannot be strictly separated from each other.

Upland Habitats

These habitats are situated on higher elevation areas of the Refuge. They include: oceanfront beach, dunes, mixed hardwood-softwood woodlands, shrublands, agricultural farm land and old fields. Historic records show that the barrier beach system was severely over grazed in the 19th century, resulting in the mobilization of large sand sheets, and moving dunes. The cutting and

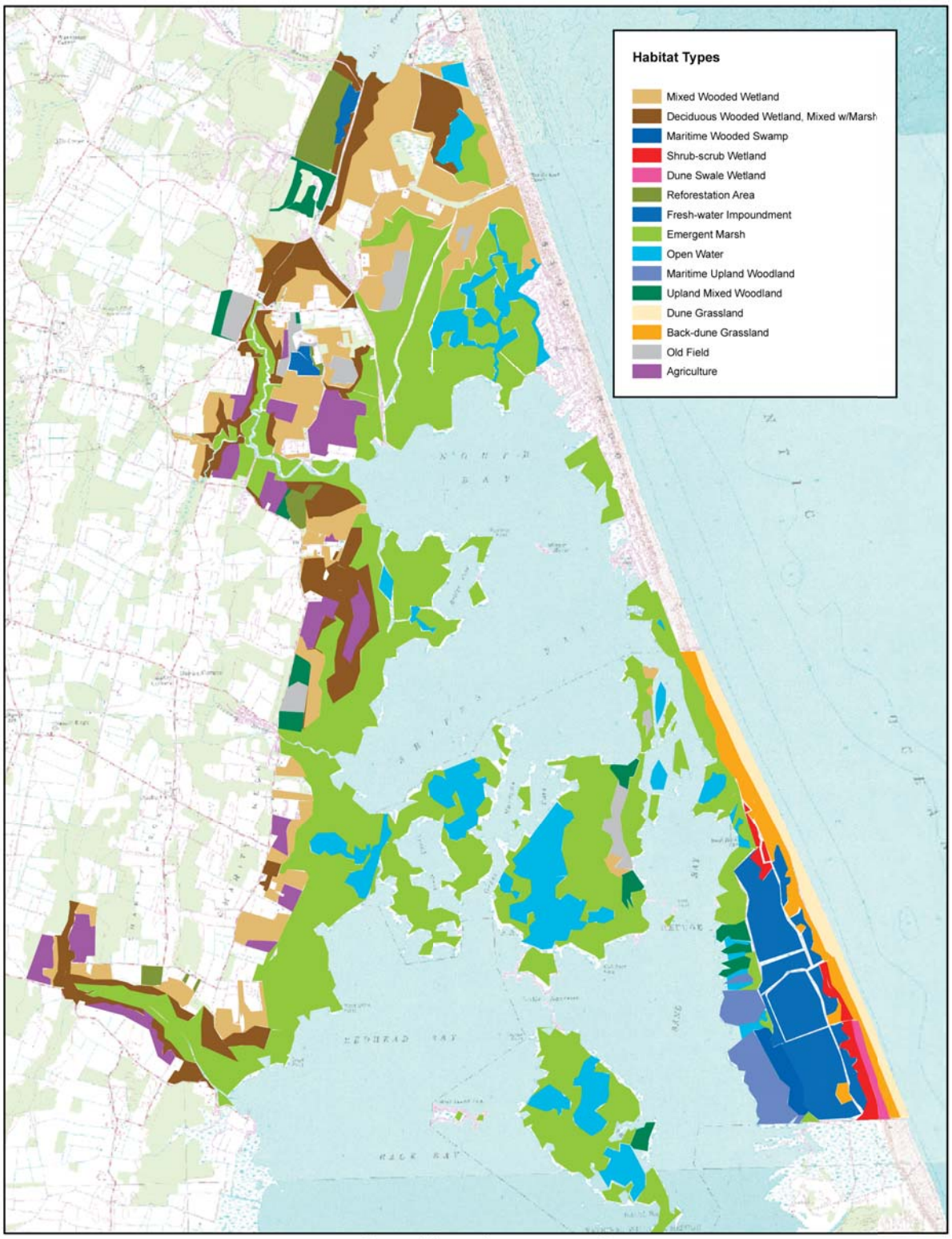
U.S. Fish & Wildlife Service

Draft Comprehensive Conservation Plan

Back Bay National Wildlife Refuge

Back Bay NWR Habitat Types

Map 3-1



Data Sources:
USGS digital orthographic data
USFWS refuge boundaries & other refuge information.

To be used for planning purposes only. December 2006.

BACK BAY NWR GIS LAB

0 0.5 1 2 Miles

0 0.5 1 2 3 Kilometers

Back Bay National Wildlife Refuge

burning of forested areas (particularly maritime forests) probably preceded the overgrazing. These forested areas have been culled many times, converting the vegetative composition of the area to its current state. Natural processes have also served to further shape the vegetative distribution and diversity on the barrier island portion of the Refuge. Depth to the water table, salt spray, substrate stability, water salinity, and periodic flooding have contributed to the existing vegetative communities' composition. The upland habitats can be divided into four types:

(1) *Beach-Dune Grasslands* — Beach vegetation is sparse, primarily located at the toe of the dunes in the wrack/debris line, and consists of sea rocket and American beachgrass. The higher dune lines are characterized by beachgrass and sea oats. In stabilized dune areas, the following species are common: sea rocket, wooly hudsonia, evening primrose, lobelia, seaside goldenrod, beach pea, sandspur, daisy fleabane and spurge. Stabilized and protected interdunal depressions develop an interesting diversity of plant species. The Refuge and adjacent False Cape State Park have listed 129 species of plants from such areas. Dominant species in these depressions include: saltmeadow cordgrass, rushes, common threesquare and broomsedge. Herbaceous plants include: water pennywort, centella and purslanes/seedboxes. Woody plants on the perimeters of wetter areas also include: groundsel, waxmyrtle, bayberry, black cherry and live oak.

(2) *Barrier Island Shrublands & Woodlands* — A shrub thicket exists along the bayshore peripheries, particularly along the western side of the barrier island, where the land is naturally or artificially protected from salt spray and overwash. The dominant shrubs and stunted trees of this community type are; waxmyrtle, highbush blueberry, American holly, yaupon, inkberry/low gallberry holly, groundsel/saltbush, red cedar and persimmon. Woody vines are also found in both the shrublands and adjacent woodlands, including: greenbriers, Virginia creeper, Japanese honeysuckle, grapes, poison ivy, trumpet creeper and false jessamine.

Shrub-thickets merge gradually into woodlands, particularly in the "Green Hills" area, north of False Cape State Park. These woodlands are generally low, reaching heights of 20 feet or less, due to the pruning effects of salt-laden winds from the ocean. Dominant species include live oak, loblolly pine, red cedar, laurel oak, red maple and sweetgum. A few pond pines can also be found in this area.

Additional upland woods are located on Long Island and the western side of Back Bay, on higher elevations. Long Island supports scattered hawthorns, and a mix of loblolly pine, waxmyrtle, hackberry, sweetgum, black cherry, persimmon, red cedar, groundsel/saltbush and a variety of oaks such as black and pin oaks.

(3) *Agricultural Farmland* — Elevations slightly below five foot mean sea level are often occupied by low-lying, poorly drained agricultural fields. In this area, agricultural lands were often previously occupied by lowland forests; but were cleared of all trees, ditched, and drained. Agriculture is the most abundant land use/vegetation type, which constitutes approximately 22% of the Back Bay watershed. Primary crops include corn, soybeans and wheat, while secondary crops consist of a variety of vegetables (Roy Associates, Inc. 1984). The farm fields which Back Bay NWR has acquired are managed under either a cooperative farming agreement, with planted crop, converted back to wetland through impoundment or wetland restoration projects, or reforested.

(4) *Old Fields* — Former agricultural fields that were purchased by the Refuge are sometimes permitted to serve the needs of Refuge songbird populations, including declining passerine species such as the field sparrow and yellow-breasted chat. These mid-successional old fields generally support a mix of young loblolly pine, waxmyrtle, groundsel/saltbush, mixed perennial grasses, blackberry briars, wooly beardgrass, and a variety of forbs. They are best managed through periodic prescribed burning fire or brush-hogging to maintain them at this successional state.

Wetlands Habitats — Marshes

Approximately 9,925 acres of wetlands are identified within the Back Bay watershed. These wetlands support a very diverse flora consisting of over 109 species. The five dominant species account for almost 75% of the wetland acreage. They include cattails (4,004 acres), black needlerush (2,371 acres), big cordgrass (605 acres), saltmeadow hay (449 acres) and switchgrass (427 acres). The remainder of the species represent a diverse mixture of brackish plants with a significant component of freshwater species (Priest III et al 1989).

Priest III et al (1990) describe the floral wetland communities as follows, "The emergent tidal wetlands are dominated by plants typically indicative of brackish conditions even though the system now tends toward freshwater conditions under normal circumstances . . . The brackish communities because of their continued dominance appear to be more adaptable to the periods of freshwater, than the freshwater species are to periods of brackish conditions. These historical oscillations between brackish and fresh conditions are probably responsible for much of the plant diversity found. These plant communities are not static either, as evidenced by changes in the coverage of common reed, *Phragmites australis*, which has increased substantially between this inventory done in 1977 and recent (1990) observations."

The above natural wetland estimates probably do not include the 900-acre Refuge impoundment complex on the barrier island portion of the Refuge; nor the 30-acre Frank Carter wetland restoration project on Colechester Road. Most of these freshwater impoundments consist of two general wetland habitats: moist soil and emergent marshes.

The moist soil areas are intensively managed areas along the eastern one third of A, B and C Pools in the 900-acre complex, and throughout most of the three impoundments in the Frank Carter site. These areas are flooded for 4-5 months and kept moist for most of the remaining 7- 8 months. They consist of sandier, slightly higher elevation, wet soils with an overlying organic layer that make them ideal for annual wetlands plant production. The sandier soils permit heavy agricultural equipment access for mowing, discing or root-raking; in order to maintain them in the early stage of plant succession needed for production of high seed yielding annuals such as beggar-ticks, bulrushes, sedges, smartweeds, wild millets, and succulents such as water hyssop, spikerushes, liliaeopsis, seedboxes, etc., that are preferred waterbird food-plants.

Emergent marsh areas principally exist along the western one-half to two-thirds of A, B and C Pools within the impoundment complex. They are usually managed to have standing water over them for 10 or 11 months of the year. These marshes consist of wetter, muckier substrates that principally accommodate perennial wetland plants. Several annuals also occur, including giant spikerush (*Eleocharis quadrangulata*) and a variety of SAV species (particularly *Myriophyllum* spp., *Potamogeton pectinatus, Ceratophyllum demersum*, and *Ruppia maritima*). Many perennials and nearly all of the annuals, particularly the SAVs, are good waterfowl foods. The more beneficial perennials include: arrow-arum, arrowheads, arrow-grass, Gibbon's panicgrass, fimbristylis, rice cut-grass,

saltmarsh bulrush, soft-stem bulrush, and to a limited extent, narrow-leaved cattail. Other perennials provide good cover, but little food value, and occupy significant acreage in the 900-acre impoundment complex. They include: black needlerush, saltmeadow hay, the invasive common reed, waxmyrtle and to a limited extent, narrow-leaved cattail. Management efforts aimed at reducing the density of these perennials are ongoing.

Several wetland sites on Long Island support unique Olney's three-square marshes and a floating spikerush marsh. They are the only known locations for these two unique marsh communities on Back Bay NWR, and thus, require protection.

Wetlands Habitats—Forested
Forested vegetative communities comprise approximately 11% of the watershed. Most of the upland forests are isolated stands surrounded by agricultural uses (Roy Mann Associates, Inc. 1984). Forested habitats within the Back Bay NWR include maritime evergreen, loblolly pine, mixed, non-riverine pine-hardwood and wet hardwood forests and estuarine fringe pine and swamp forests. According to the Natural Heritage Division of the Virginia Department of Conservation and Recreation, most of these communities range from globally rare to uncommon and rare to uncommon in the state of Virginia. The following forest types and species compositions are taken from Walton et al (2001).

(1) *Maritime Evergreen Forests* are located on back dunes and leeward sides of stabilized dunes. They are protected from the ocean salt spray and reach their northernmost limit along the southeast coast of Virginia. Dominant species include live oak mixed with loblolly pine, Darlington's oak and black cherry. The understory consists of poison ivy, common greenbrier, southern bayberry, American holly, devilwood, and highbush blueberry. Ground cover species are yellow jesamine and narrow-leaved golden-aster; dead oak leaves also contribute to the amount of ground cover.

(2) *Maritime Loblolly Pine Forests* are located on ocean-side dunes, bay-side dunes and sand flats that are usually protected from salt-spray. They are dominated by loblolly pine with an understory of dense red maple black cherry, and/or sassafras. Southern bayberry and highbush blueberry make up the shrub layer, while the herbaceous layer is sparse and low in diversity.

(3) *Maritime Mixed Forests* are located on leeward slopes of bay-side dunes or old ocean-side dunes. They are protected from salt spray and winds, and therefore, have a mix of loblolly pine, water oak, southern red oak and black cherry. The understory includes American holly, while the shrub and herb layers consist of common greenbrier and muscadine grape.

(4) *Maritime Swamp Forests* are seasonally flooded, or sometimes saturated, maritime wetland forests. These communities are within protected interdune swales or along sluggish streams inland from estuarine zones. They are characterized by hummock-and-hollow microtopography with seasonally standing water. Dominant species include red maple, sweetgum, blackgum, black willow and sweetbay. The shrub layer consists of highbush blueberries, southern bayberry, red bay, and greenbriers, while the herbaceous layers are dominated by Virginia chain fern.

(5) *Non-Riverine Pine*—Hardwood Forests are located in flat, seasonally perched water tables with frequent shallow depressions, which hold water intermittently. Dominant species are loblolly pine, red maple and sweetgum, with scattered pond pine. Other species include sweetbay, blackgum, red bay, and coastal dog-hobble. The shrub layer is typically dominated by giant cane, while the herbaceous layer is sparse.

(6) *Non-Riverine Wet Hardwood Forests* are located in flat, seasonally perched water tables and shallow depressions that hold water intermittently. Species vary regionally and may include swamp chestnut oak, cherrybark oak, willow oak, laurel oak, water oak, and pin oak. Intolerant trees, such as sweetgum and red maple may establish if oaks are cut or disturbed such as sweetgum and red maple for example. The herbaceous understory may include American hornbeam, giant cane, American holly, coastal dog-hobble and highbush blueberries. While the herbaceous layer consists of netted chain-fern and sedges.

(7) *Estuarine Fringe Pine Forests* are saturated coniferous maritime forests located in the back dunes of barrier islands and terrace flats further inland. The dominant canopy species is loblolly pine with southern bayberry, pond pine, inkberry, common greenbrier, poison ivy, cinnamon fern, royal fern, switchgrass and smartweeds. Giant cane may also be present.

(8) *Estuarine Fringe Swamp Forests* are mixed forests subject to irregular wind-tidal flooding. The water table salinity fluctuates between fresh (0 ppt) and 5 ppt., and usually borders wind-tidal marshes. Dominant canopy species include bald cypress, swamp tupelo, and loblolly pine. The understory consists of sweetbay and redbay while the shrub layer is southern bayberry. Royal fern dominates the herbaceous layer.

Wetland Habitats — Impoundments

In the 1930's, a dune system was created along the beach edge. The Civilian Conservation Corps built brush fences and planted cane and bulrush to catch the blowing sand. Later on, beachgrass was planted to stabilize the dunes. This protected the bayside flats and by the 1970's, Back Bay NWR converted approximately 650 acres of mostly unvegetated wash flats to freshwater impoundments.

These impoundments evolved from a simple "ring dike"system with 3 units, to an efficient, manageable system that includes 10 units with two storage pools, water control structures and a water pump that allows water levels to be altered throughout the year. Wildlife management of this area involves surveys of population size and species diversity to determine use trends; together with the control of undesirable species and encouragement of desirable species, through mechanical, chemical and aquatic habitat management tools. Habitat management techniques include discing, root raking, mowing, burning, invasive species control and water level manipulations. During the spring and fall, the Refuge draws down pool water levels to provide migrating shorebirds with exposed mud flats rich in invertebrates. Pool levels are gradually raised in the fall and winter to flood the various rushes, sedges, smartweeds, bacopa, millets, etc. to feed wintering and migrating waterfowl.

The impoundments include *A-pool, B-pool, C-pool, D-pool, E-pool, G-pool, H-pool, J-pool* and two water storage pools, *C-Storage* and *B-Storage Pools.*

A-pool.	*A-pool* is the most southern and largest impoundment, containing **215 acres**. One hundred and ninety-three acres are emergent wetlands, 10 acres are upland (along the southeastern side), and 12 acres are wooded swamp (along the western side). Deep-water ditches run along the northern and southern ends; they are connected by two shallow 'Gemco' ditches that run north to south.
B-pool	*B-pool,* located between A and C pools, is approximately **100 acres**, of which 96% is emergent wetlands. The highest ground is located on several tiny islands in the mid-eastern portion of the pool.

C-pool	The second largest impoundment is *C-pool*, which consists of **190 acres** of emergent marshes, open water and higher-elevation islands along the eastern side and deep-water ditches.
D-pool	*D-pool* is currently designated for recreational fishing activities. This **17-acre** unit supports upland grasses, waxmyrtles and small patches of three-square and black needlerush. The interior perimeter consists of a wide, deep-water ditches that support a viable game-fish population. Areas adjacent to the deep-ditch are shallower to support spawning and bait-fish/prey populations.
E-pool	*E-pool* is approximately **25 acres**. It is dominated by upland grasses in the southern half, and by three-square and diverse emergent wetland plants in the northern half.
G-pool	*G-Pool's* **88 acres** consist of a mix of lower elevation wetlands, and higher elevation, dune-associated habitats. A deep-water ditch exists along the eastern side. Prior thoughts on letting this unit revert to shrub-scrub have been abandoned since wintering waterfowl use has begun to increase.
H-pool	*H-Pool* consists of **76 acres** of mixed wetlands and higher elevation dune grasslands. A deep-water ditch exists along the eastern side. G, H and J Pools are also referred to as "dune pools" since they were reclaimed from former dune habitat in 1993. As with the other two "dune pools," H-Pool's wetlands are dominated by common threesquare, black needlerush, spikerushes and wild millets; while the higher elevation areas are dominated by live oaks, southern waxmyrtle and switchgrass.
J-pool	*J-pool* is **111 acres,** with 33 acres containing wooded swamp, and the remainder a mix of wetlands and higher elevation, dune-associated habitats. Three-square and black needle rush dominate the remaining wetlands, while live oak and waxmyrtle represent the upland.
C-storage pool	*C-storage pool* is the main water storage unit. It contains approximately **45 acres**. A 12,000 gallon per minute pumping station is located on its West Dike. The station pumps water from Back Bay into this Unit from where it is distributed to other surrounding impoundments via connecting water control structures. C-storage pool is nearly all open water, with the shallower eastern side supporting some emergent wetland and scattered "islands" with waxmyrtles and live oaks.
B-storage pool.	*B-storage pool* is approximately **13 acres** of deep-water ditching emergent wetland and mixed forest. A small four acre remnant mixed hardwood and softwood forest is along the southern end. Emergent wetland plants include: pondweeds, bladderwort, red-rooted nutsedge, smartweed, beggarticks, black needlerush and water primrose.

Islands and Marshy Peninsulas
The Refuge currently owns approximately 2,400 acres of bay islands. This includes the marsh fingers to the west of B-storage, C-storage, C-Pools, as well as Long Island, Ragged Island and all other unnamed islands. Most of these islands are washed over by the bay, and therefore severely eroded.

Long Island is approximately 800 acres. This includes 55 acres of old fields that are slowly reverting back to woodland and 50 acres of mixed loblolly pine-red-maple forest. The remaining acreage consists of emergent black needlerush marshes, ponds, small guts and inlets.

Ragged Island is the next largest bay island and is approximately 700 acres of emergent needlerush marshes, scattered waxmyrtle and open water or "potholes." The remaining 900 acres of bay islands and marsh fingers are emergent needlerush marshes, open water coves, waterways and potholes, interspersed with phragmites stands, waxmyrtle and three-square.

Other Non-forested Habitats
Other vegetative communities include maritime dune grasslands, maritime scrub, maritime wet grasslands, maritime shrub swamps, interdune ponds, wind-tidal oligohaline marshes, upper beaches, overwash flats and SAVs. According to the State of Virginia, most of these communities are globally uncommon to rare in Virginia. The following habitat types and species compositions are taken from Walton et al. (2001).

(1) *Maritime Dune Grasslands* are coastal communities of ocean/bay-fronting dunes influenced by storm surges. Dominant species include saltmeadow

cordgrass, American beachgrass, sea oats, and seaside little bluestem. Low cover species consist of seaside goldenrod, sea-beach evening-primrose, seaside spurge, purple lovegrass, purple sandgrass and dune sandbur.

(2) *Maritime Scrub* are shrubland communities that occupy inland edges of maritime dune systems that are sheltered from constant ocean salt spray. Species are usually stunted and include dominant northern bayberry, live oak, persimmon, and black cherry. Canopy gaps will support species found in dune grasslands such as dwarf shrub sand-heather, beach goldenrod, bitter beach grass, Gray's flatsedge, and beach pinweed.

(3) *Maritime Wet Grasslands* are graminoid-dominated seasonal wetlands within maritime dunes. Dominant species are saltmeadow cordgrass, rushes and/or sedges. Other species include slender goldenrod, long-leaved aster, yellow-eyed grass, dwarf umbrella-sedge, ladies'-tresses, spoon-leaved sundew and others.

(4) *Maritime Shrub Swamps* are seasonally flooded shrublands of sheltered maritime dune hollows. This habitat typically holds fresh water, throughout most of the year though saltwater may be present after storm surges. Species include southern bayberry, inkberry, highbush blueberry, poison ivy, royal fern, marsh fern, netted chain fern, Virginia chain fern and whorled water-pennywort.

(5) *Interdune Ponds* are seasonally to semi-permanently flooded, maritime herbaceous wetlands in interdune basins and swales. This group includes freshwater and slightly brackish ponds or best characterized as oligohaline ponds. The community composition depends upon the geography, topography, exposures to storm surges and salt spray, hydroperiod and soil properties. Seasonally flooded freshwater ponds contain bulrushes, grasses and/or squarestem spikerush, while seasonally flooded oligohaline ponds may be dominated by narrow-leaved cattail, eastern rose-mallow, and/or saltmarsh bulrush. Semi-permanently flooded oligohaline ponds consist of coastal water-hyssop, white spikerush, and sago pondweed.

(6) *Wind-Tidal Oligohaline Marshes* are herbaceous wetlands subject to wind-tidal flooding along estuaries that no longer have oceanic influences. The water regimes of this group ranges from fresh to brackish (5ppt). Therefore, there is usually a mixture of freshwater and saltwater species. Tall marsh graminoids such as big cordgrass, black needlerush and cattails are common, though in patches. However, more diverse tall marshes with big cordgrass, sawgrass, switchgrass, marsh horned beakrush, eastern rose-mallow also occur. Short statured marshes are usually more locally distributed and include creeping spikerush, beaked spikerush, twigrush, Olney three-square, pickerelweed, dotted smartweed and Canada rush.

(7) *Upper Beaches and Overwash Flats* are sparsely vegetated habitats that are situated behind breached foredunes just above the mean high tide line, but are flooded during spring tides and storm surges. Common species include American searocket and Russian-thistle. Other species are Sea-purslane, Sea-beach knotweed, Bushy knotweed, sea-blites and Sea-beach orach.

(8) *Submerged Aquatic Vegetation (SAV)* is an important aspect to a healthy ecosystem in Back Bay. SAVs provide important habitats and support a greater diversity of wildlife species, help to stabilize sediments, deter shoreline erosion and filter pollutants and dissolved nutrients. SAV in Back Bay has shown periods of noticeable peaks and declines since the 1920's; with two periods of high frequency and two declines between 1954 – 1990.

Disease, run-off, changes in salinity, turbidity, weather and various natural occurrences are causes for the decline of SAVs (Schwab et al. 1990).

Threatened or Endangered Plants

According to the Virginia Natural Heritage Division, there are no Federal or State listed plant species on Back Bay NWR. However, rare to uncommon species have been recorded on the Refuge (Table 3.2).

During 2000, an inventory of Refuge habitats was carried out in search of rare plant and animal species by Virginia Department of Conservation and Recreation's Division of Natural Heritage. The resulting technical report #01-8 (Walton et al. 2001) details historic and current sightings of rare plant species on pages 18 to 20. Many of the following plants were reported prior to the 2000 inventory, but not observed then principally because of a lack of field time to adequately explore the habitats these species were observed in previously. It is likely that some of these species are still present in the indicated areas.

Table 3.2. Rare Plants Recorded in the Back Bay NWR (Source: Walton et al. 2001)

Taxon	Common Name	Last Seen
Eleocharis vivipara	viviparous spikerush	1973 (Black Gut)
Ludwigia brevipes	long beach seedbox	1988, 1990, 1991, 2000 (Black Gut, south end of impoundments & E-Pool)
Crataegus aestivalis	May hawthorn	1939
Juncus elliotti	bog rush	1939, 1947
Juncus megacephalus	big-headed rush	1939, 1988, 2005-2006 (Impoundments)
Lilaeopsis carolinensis	Carolina lilaeopsis	1939,1992-2006 (east impoundments, bayshores)
Rhynchospora colorata	white-topped sedge	1939, 1965, 1988, 2003-2006 (Impoundments & eastern Long Island)
Ludwigia alata	winged seedbox	1991, 2000 (Long Island & North Bay Marshes)
Erigeron vernus	white-top fleabane	1988, 2000 (Impoundments & dune swales nr. D & E Pools.)
Iva imbricata	sea-coast marsh-elder	1939
Ludwigia repens	creeping seedbox	1988 (Impoundments)
Phyla nodiflora	common frog-fruit	1947, 1988 (Impoundments)
Rhynchospora debilis	savannah beakrush	1952
Rhynchospora fascicularis	fasciculate beakrush	1988 (South end of Impoundments)
Vaccinium macrocarpon	large cranberry	1988 (Impoundments)
Verbena scabra	sandpaper vervain	1939, 1947
Hydrocotyle bonariensis	coastal water-pennywort	2000 (Dunes east of Refuge entrance road.)
Lipocarpha maculata	American lipocarpha	2000 (South end of Impoundments)

Taxon	Common Name	Last Seen
Tillandsia usneoides	Spanish moss	1946
Cladium jamaicense	sawgrass	prior 2000 (southern G-Pool)
Paspalum distichum	joint paspalum	2000-2006 (Impoundments)
Paspalum dissectum	A paspalum	1995-2004 (A, B & C Pools)
Aster puniceus	Elliott's aster	Prior to 2000
Calopogon pallidus	pale grass-pink	prior to 2000
Carex reniformis	reniformis sedge	prior to 2000
Chamaesyce bombensis	southern beach spurge	prior to 2000
Chrysopsis gossypina	cottony golden-aster	prior to 2000
Desmodium strictum	pineland tick-trefoil	prior to 2000
Eleocharis halophila	salt-marsh spikerush	prior to 2000
Eleocharis radicans	rooted spikerush	prior to 2000
Fimbristylis puberula	hairy fimbry	prior to 2000
Heliotropium curassavicum	seaside heliotrope	prior to 2000
Hottonia inflata	featherfoil	prior to 2000
Hypoxis sessilis	glossy-seeded stargrass	prior to 2000
Juncus abortivus	pine barren rush	prior to 2000
Limosella australis	mudwort	prior to 2000
Lobelia elongata	elongate lobelia	prior to 2000
Physalis walteri	dune ground-cherry	prior to 2000
Quercus hemisphaerica	Darlington's oak	prior to 2000
Quercus incana	bluejack oak	prior to 2000
Schoenoplectus acutus	hard-stemmed bulrush	prior to 2000
Ranunculus hederaceus	ivy-leaved water crowfoot	prior to 2000
Sparganium androcladum	branching burreed	prior to 2000
Utricularia striata	fibrous bladderwort	prior to 2000
Wolffia columbiana	Columbia watermeal	prior to 2000

Unique Ecosystems

The State of Virginia's Natural Heritage Division has designated certain areas of the Refuge as Natural Areas because of their intact and unique natural environments. These areas include North Bay Marshes, Black Gut, Muddy Creek, Porpoise Point and Nanney Creek.

The North Bay Marshes Natural Area and Black Gut Natural Area include Hell Point Creek, Black Gut, a series of large, connected marsh potholes, and acreage on both sides of eastern Sandbridge Road. The 2,020 acres include emergent needlerush marshes, potholes, bottomland woodlands, and agricultural and old fields. The North Bay Marshes Natural Area contains the rare plant winged seedbox while the Black Gut Natural Area contains Carolina fimbristylis, long beach seedbox and viviparous spikerush. This area also holds rare bird and insect species such as the king rail and least bittern and the saffron skipper and stripe-winged baskettail.

The Muddy Creek Natural Area contains approximately 400 acres along both sides of Muddy and Asheville Bridge Creeks. The Porpoise Point Natural Area includes 780 acres between Beggar's Bridge Creek and Porpoise Point. The habitats for these two Natural Areas include emergent needlerush marshes, potholes, lowland woodlands and agricultural and old fields. The Muddy Creek Natural Area holds rare species such as Carolina liliaeopsis (a rare plant in Virginia) and crow-poison. Porpoise Point Natural Area contains elongated lobelia and winged seedbox. Nanney Creek Natural Area contains 610 acres of wetlands on both sides of Nanney Creek, and also holds Carolina liliaeopsis.

Diversity of Plant Communities

The Back Bay region is unique for the occurrence of many rare plants at their extreme limits, either north or south. The presence of these uncommon to rare species make the vegetation of the Back Bay region a unique component of the state flora (Knepper et al 1990).

The following northern species exist on the Refuge and are near their southernmost limit:

Limosella subulata (a mudwort)
Cyperus engelmanii (Engelman's bulrush)
Eleocharis halophila (salt-marsh spikerush)
Cyperus haspan (a bulrush)
Dichromena colorata

The following southern species exist on the Refuge and are near their northernmost limit:

Liliaeopsis carolinensis (Carolina liliaeopsis)
Cladium jamaicense (Sawgrass)
Eleocharis radicans (a spikerush)
Arenaria lanuginosa (a sandwort)
Physalis viscosa (unknown common name)
Lippia nodiflora (a frog-fruit)
Bacopa monnieri (a water hyssop)
Erigeron vernus (a fleabane)
Iva imbricata (a marsh-elder)
Juncus megacephalus (big-headed rush).
Quercus virginiana (Live oak)
Pinus serotina (Pond pine)
Taxodium distichum (Bald Cypress)

Noxious Weeds

The Common reed (*Phragmites australis)* is the primary invasive in the Back Bay watershed. This invasive is a substantial threat to the watershed's marsh flora. It quickly invades disturbed wetlands forming extensive dense stands that exclude native species (Ludwig et al. 1990). Species diversity is also minimized, thereby negatively effecting the quality of habitat for wildlife species.

The Virginia Institute of Marine Science (VIMS) documented a five to ten-fold increase in the percent cover of common reed between 1977 to 1990 (Clark 1997). During one of their low level overflights in 1990, VIMS estimated an average 10 % cover of Phragmites within the Back Bay watershed. One explanation for the wide spread of this invasive grass was the large scale dredging and filling projects during the 1960s and early 1970s. These activities provided sufficient disturbance to the natural flora for common reed to become well established. Since then, its aggressive growth habits have allowed it to continue spreading and out-compete the native vegetation (Priest III et al. 1990).

The Refuge has been actively controlling Phragmites reed since 1987 through aerial and ground applications of Glyphosate-based herbicides (Rodeo," "Glypro" and "Aqua-Neat") approved for use in wetlands. Dense stands of dead Phragmites stems have been removed by controlled burns to promote the growth of native and more desirable species. Glyphosate applications, followed by burning of the dead stand, have been successfully used in the impoundments, and most recently on Long Island.

Japanese stiltgrass is wide-spread in woodlands and woodland edges of the Back Bay Refuge. It is an annual grass native to Asia, India and Japan. It invades naturally (via flood scouring) and artificially (via mowing, tilling, etc.) and quickly displaces native vegetation. It then degrades quality nesting habitat for quail and other wildlife. Japanese stiltgrass is shade tolerant and prefers moist and well-drained soils. Once Japanese stiltgrass is established, control methods, such as mechanical, manual, environmental (flooding or burning) and chemical can be used at varying degrees (Tu 2000).

Biological Environment— Wildlife

Wildlife Habitat

The Back Bay NWR environment consists of several, unique high-quality habitats. The oligohaline nature of the Back Bay ecosystem has resulted in the unique establishment of various freshwater, wetland communities in bay areas behind the oceanfront, barrier island, that are normally very brackish. In addition, the geographic, "mid-way location" of Back Bay along the East Coast, places it in the overlap area at the extreme range limits of many northern and southern plant and animal species.

Birds

The unique diversity of Refuge habitats results in a high diversity of migratory birds, particularly during their spring and fall migrations. Migratory birds are broken down into categories of waterfowl, wading birds, shorebirds, gulls, terns, marsh birds, raptors and passerines.

Waterfowl — The variety of wetlands habitats within and adjacent to Back Bay attract 17 duck species, including mallard, black duck, gadwall, widgeon and pintail, Canada goose, snow goose, and tundra swan. Lesser numbers of wood duck, shoveler, bufflehead, ruddy duck, hooded merganser and ring-necked duck

and lesser scaup also migrate through and/or winter within the impoundment complex, coves and natural potholes of the Back Bay watershed. Just offshore, along the Atlantic Ocean-front, the red-throated and common loons, horned and red-necked grebes, several scoter species and the red-breasted merganser feed and rest during their spring and fall migrations.

Wintering waterfowl population size is correlated with that year's SAV production in the bay. High SAV production usually results in high wintering populations (Figure 3.9). However, SAV has been declining for many decades, which in turn results in one of the causes of low waterfowl populations. The following graph indicates this close relationship between SAV and waterfowl populations (Settle and Schwab 1991).

Figure 3.9. Total Waterfowl and % Frequency of Submerged Aquatic Vegetation (SAV).

In general, waterfowl populations of various species have been declining at Back Bay for at least a half-century. The reasons for this are complex and may be separated into local and regional factors. Local factors include reductions in SAV, which may link to potential decreases in water quality. However, some water quality elements (such as nitrates and suspended solids) in Back Bay have been improving over the past two decades while SAV level remain low. This indicates a more complex relationship between waterfowl, SAV and water quality. Regional factors in decreasing Back Bay waterfowl populations may include the shifting of primary over-wintering locations in the Atlantic Waterfowl Flyway, primarily northward, out of the Back Bay area; as well as overall declines in Atlantic Flyway populations.

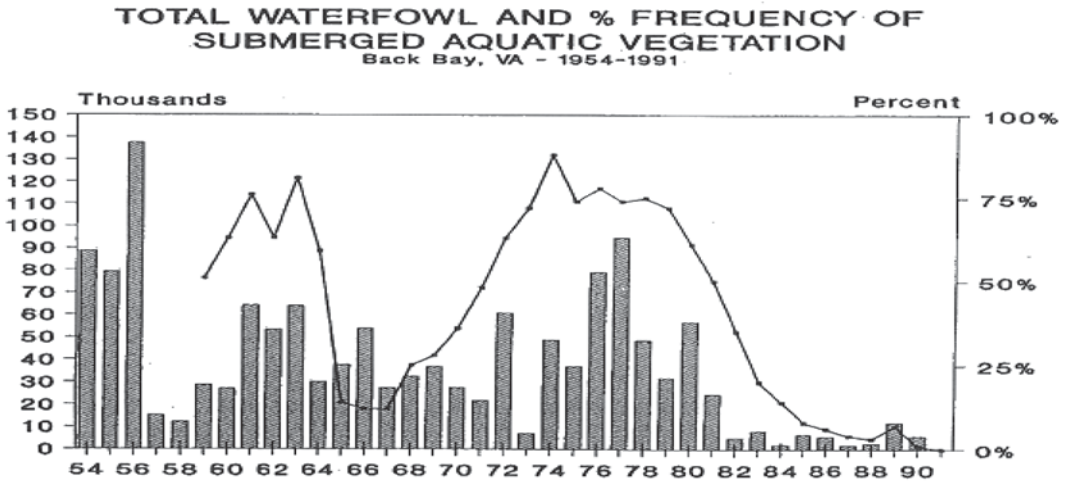
The following table summarizes these main temporal trends of waterfowl species in a local and regional context (Table 3.3). Out of the eighteen primary waterfowl species occurring in Back Bay, eight have decreased, two increased, two are variable or stable, and the remaining six have insufficient data to determine long-term trends. These trends assume no errors or misrepresentations inherent in the collection of data. Inconsistencies in sampling methods do occur between the VA-MD-NC data from the Atlantic Flyway Mid-Winter and the Audubon Christmas Bird Count surveys.

The trends for nine waterfowl species are provided in the following series of nine graphs (Figure 3.10 to 3.18). Back Bay NWR (BKB, solid squares, right axis) numbers are compared to Atlantic Flyway Mid-Winter Survey numbers (AF-MWS, broken line, right axis) and Virginia-Maryland-North Carolina National Audubon Society Christmas Bird Count numbers observed per hour (VA/MD/NC-CBC, open diamonds, left axis). All graphs, for each geographic location, indicate declining populations since about 1960. The exceptions are geese and swans, which show increasing populations at the Atlantic Flyway geographic level.

Wading birds — Wading bird populations vary with the season. Most species are present only during their migrations and throughout the summer. The only exception is the great blue heron, which can be seen year-round. Common waders include the great and snowy egrets, the great blue, little blue and tricolored herons, and the glossy ibis. The white ibis, American bittern, least bittern, green-backed and black-crowned night heron are also present, but in lesser numbers. Impoundment water levels are drawn down during July to provide additional fish and amphibian forage for these birds, particularly young of the year, prior to their migrations.

Table 3.3. Regional Waterfowl Summaries—trends over time and space

	1960-2000	1959-1993	1940-2003	1955-2003	1955-2003	ATLANTIC FLYWAY SHIFT (1955-2003)			
	BACK BAY[1]	CHESAPEAKE[2]	VA-MD-NC[3]	VA-MD-NC[4]	ATL. FLYWAY[4]	Northward[4]	Southward[4]	From	To
SWANS AND GEESE									
Snow Goose	v	^	v	^	^	YES		MD-VA-NC	NJ-DE



	1960-2000	1959-1993	1940-2003	1955-2003	1955-2003	ATLANTIC FLYWAY SHIFT (1955-2003)			
	BACK BAY[1]	CHESAPEAKE[2]	VA-MD-NC[3]	VA-MD-NC[4]	ATL. FLYWAY[4]	Northward[4]	Southward[4]	From	To
Canada Goose	v	^	v	–	^	YES		MD-VA-NC	NJ-DE
Tundra Swan	v	–	v	^	^		YES	MD	NC
DABBLING DUCKS				v	v				
American Wigeon	v	v	v	v	v	YES		SC-GA-FL	MD-VA-NC-DE-NJ

	1960-2000	1959-1993	1940-2003	1955-2003	1955-2003	ATLANTIC FLYWAY SHIFT (1955-2003)			
	BACK BAY[1]	CHESAPEAKE[2]	VA-MD-NC[3]	VA-MD-NC[4]	ATL. FLYWAY[4]	Northward[4]	Southward[4]	From	To
American Black Duck	v	v	v	v	v	YES		MD-VA-NC	NJ-DE
Mallard	–	^	v	–	v	YES		SC-GA-FL	MD-VA-NC-DE-NJ
Northern Pintail	v	v	v	v	v	YES		SC-GA-FL	MD-VA-NC
Green-winged Teal	–	–	v						
Gadwall	v	–	v						
Wood Duck	^		v						
Northern Shoveler	?	–	v						
DIVING DUCKS				–	v				
Ruddy Duck	?	v	v						
Redhead	?	v	v						
Canvasback	?	v	v	v	v				
Scaup spp.		–	v	–	v				
DIVING DUCKS *(cont.)*				–	v				
Bufflehead	?	^	^						
Ring-necked Duck	?	–	v						
OTHER DUCKS									
Hooded Merganser	^	^	^						
American Coot	v		v						

Sources:

1 *Back Bay NWR Waterfowl Survey Data*

2 *Edward Pendleton. Natural Resources in the Chesapeake Bay Watershed http://biology.usgs.gov/s+t/noframe/m4148.htm*

3 *National Audubon Society Christmas Bird Count Data*

v *Decreasing*
^ *Increasing*
– *Stable/Variable*
? *Insufficient Data*

[4] *Atlantic Flyway Mid-Winter Waterfowl Survey, Office of Migratory Bird Management, Laurel, Maryland, http://mbdcapps.fws.gov/mwsoptions.asp*

[5] *Waterfowl Population Status, 2003, http://migratorybirds.fws.gov/reports/reports.html*

Figure 3.10. Regional Snow goose populations—trends over time and space (*VG = Virginia, MD = Maryland, NC = North Carolina, CBC = Christmas Bird Counts, AF-MWS= Atlantic Flyway -Mid-Winter Waterfowl Survey, BKB = Back Bay National Wildlife Refuge*)

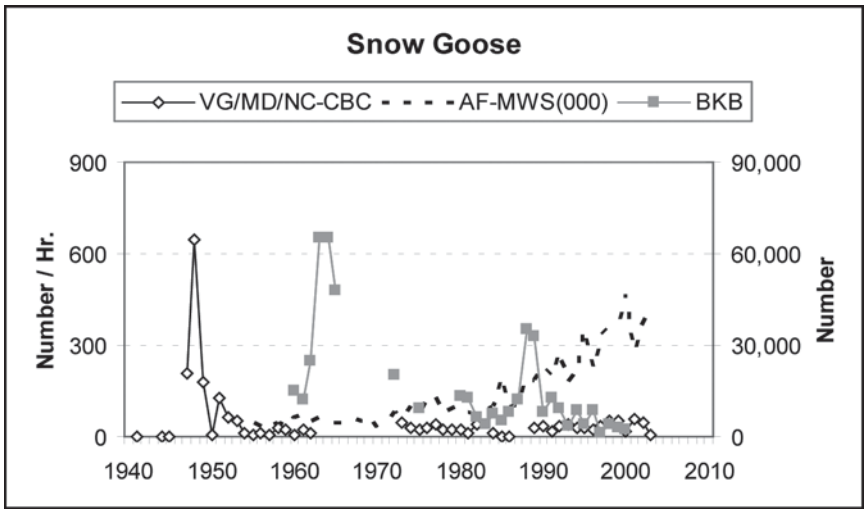


Figure 3.11. Regional Canada goose populations—trends over time and space (*VG = Virginia, MD = Maryland, NC = North Carolina, CBC = Christmas Bird Counts, AF-MWS= Atlantic Flyway -Mid-Winter Waterfowl Survey, BKB = Back Bay National Wildlife Refuge*)

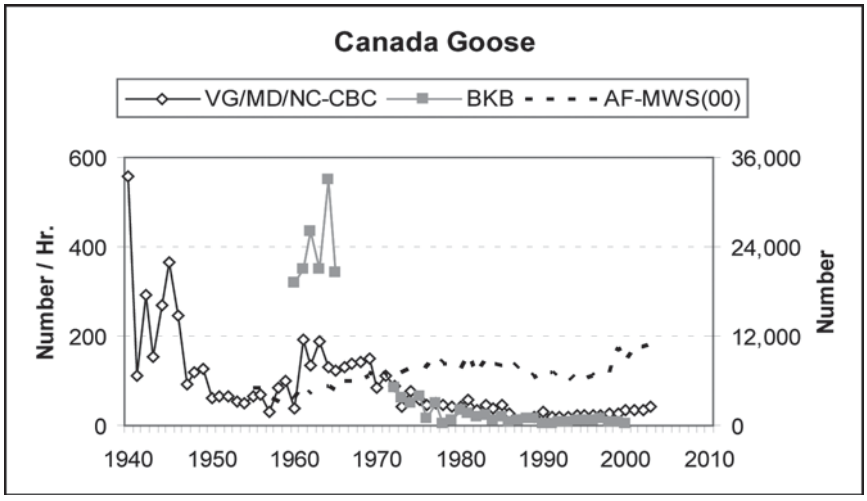


Figure 3.12. Regional Tundra swan populations—trends over time and space (*VG = Virginia, MD = Maryland, NC = North Carolina, CBC = Christmas Bird Counts, AF-MWS= Atlantic Flyway -Mid-Winter Waterfowl Survey, BKB = Back Bay National Wildlife Refuge*)

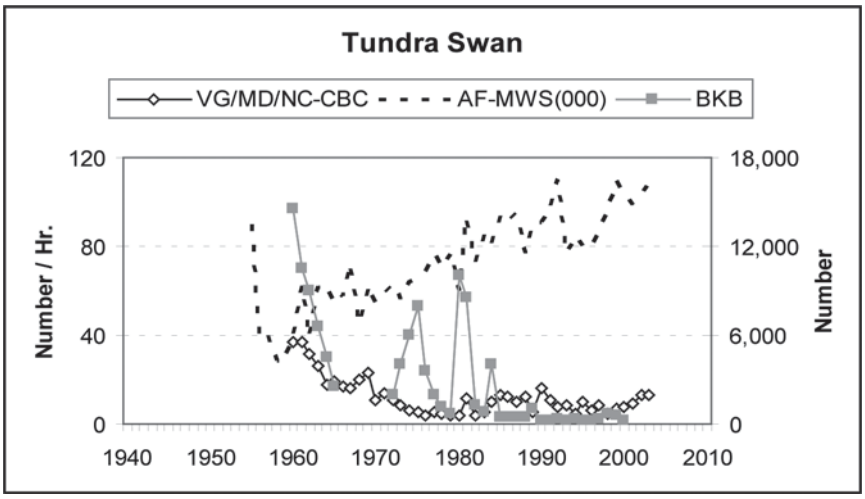


Figure 3.13. Regional American Wigeon populations—trends over time and space (*VG = Virginia, MD = Maryland, NC = North Carolina, CBC = Christmas Bird Counts, AF-MWS= Atlantic Flyway -Mid-Winter Waterfowl Survey, BKB = Back Bay National Wildlife Refuge*)

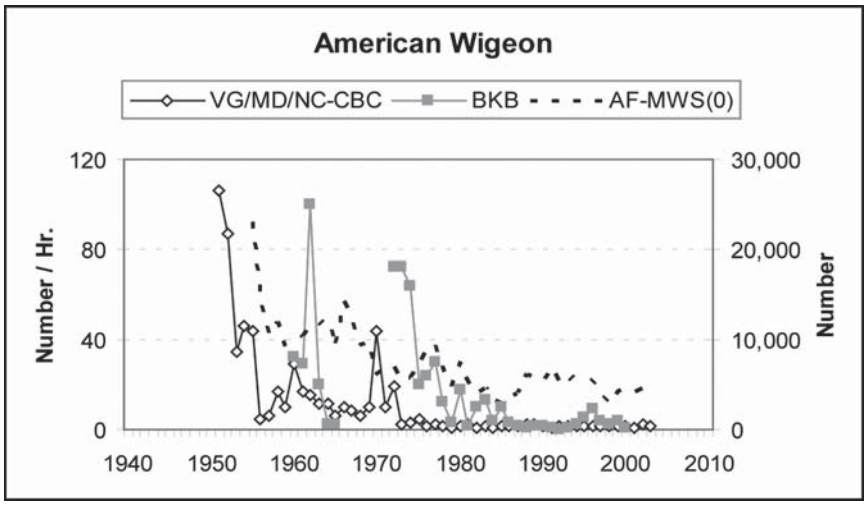


Figure 3.14. Regional Black duck populations—trends over time and space (*VG = Virginia, MD = Maryland, NC = North Carolina, CBC = Christmas Bird Counts, AF-MWS= Atlantic Flyway -Mid-Winter Waterfowl Survey, BKB = Back Bay National Wildlife Refuge*)

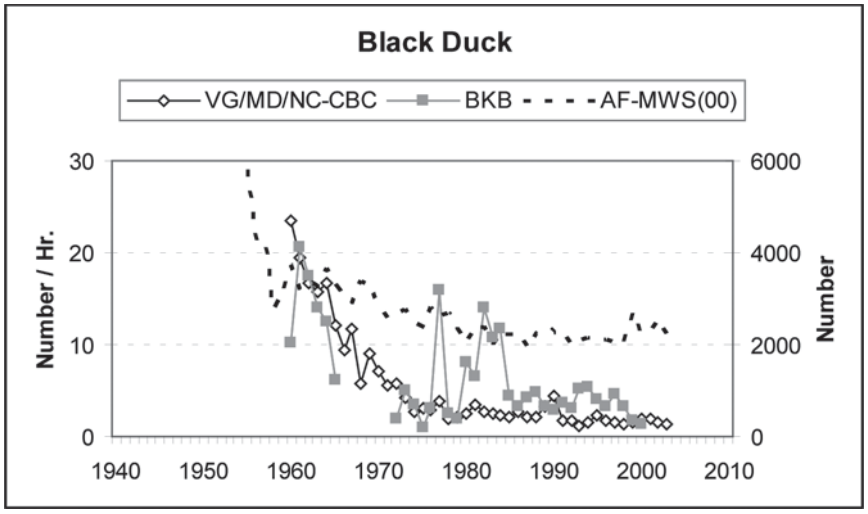


Figure 3.15. Regional Mallard populations—trends over time and space (*VG = Virginia, MD = Maryland, NC = North Carolina, CBC = Christmas Bird Counts, AF-MWS= Atlantic Flyway -Mid-Winter Waterfowl Survey, BKB = Back Bay National Wildlife Refuge*)

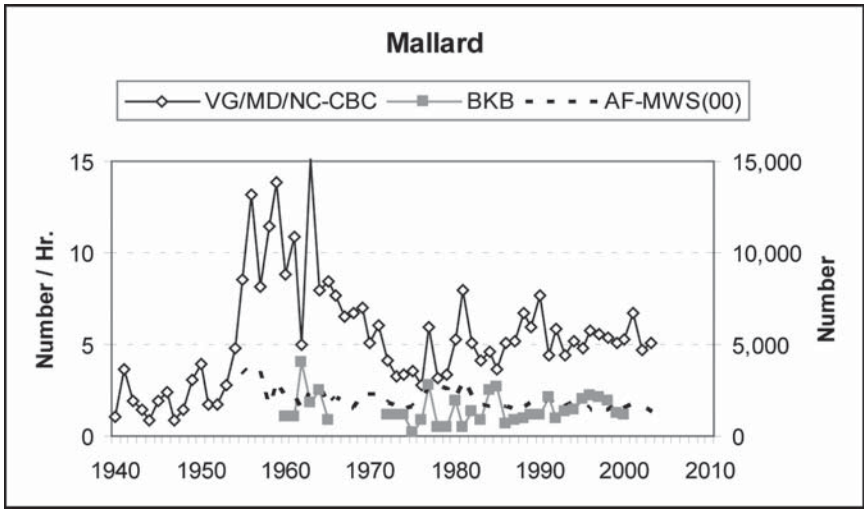


Figure 3.16. Regional Northern pintail populations—trends over time and space (*VG = Virginia, MD = Maryland, NC = North Carolina, CBC = Christmas Bird Counts, AF-MWS= Atlantic Flyway -Mid-Winter Waterfowl Survey, BKB = Back Bay National Wildlife Refuge*)

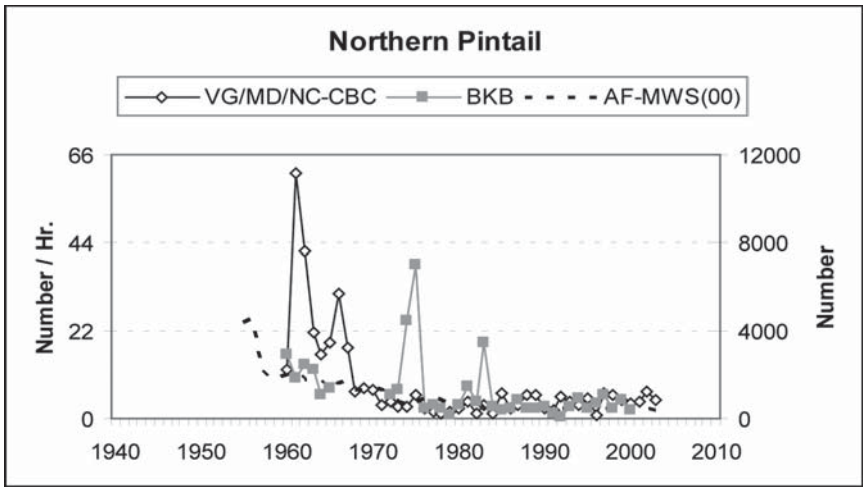


Figure 3.17. Regional Green-winged teal populations—trends over time and space (*VG = Virginia, MD = Maryland, NC = North Carolina, CBC = Christmas Bird Counts, AF-MWS= Atlantic Flyway -Mid-Winter Waterfowl Survey, BKB = Back Bay National Wildlife Refuge*)

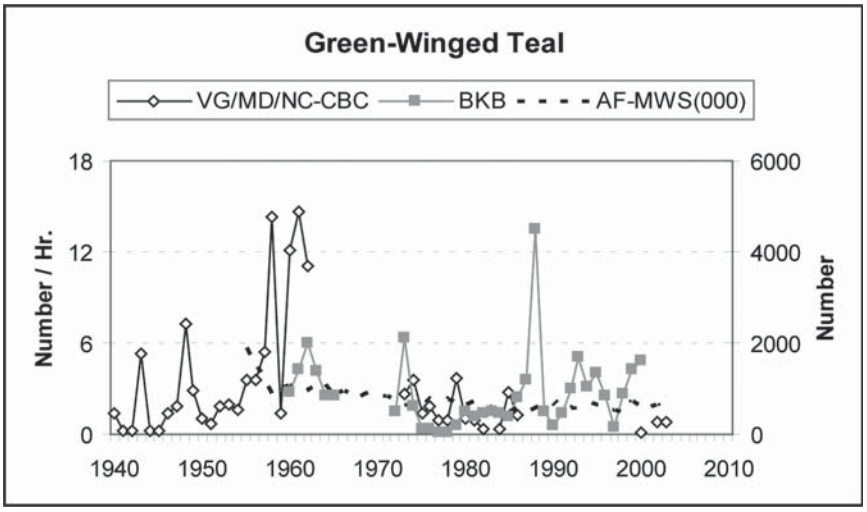
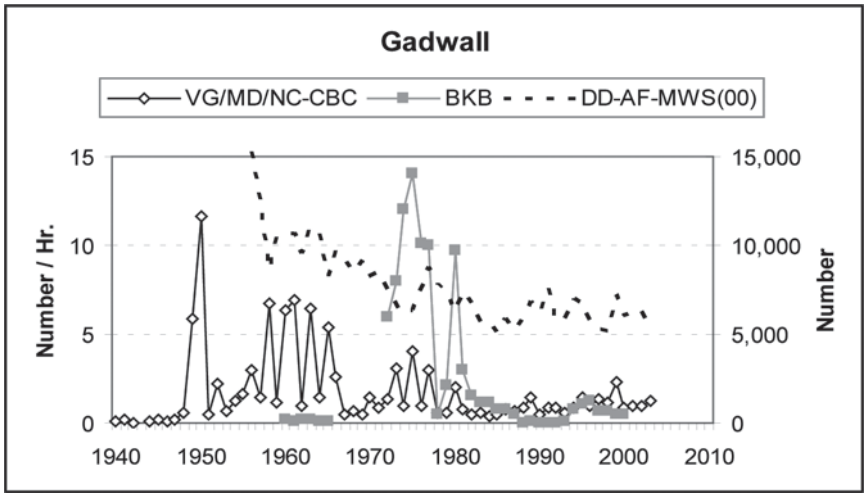


Figure 3.18. Regional Gadwall populations—trends over time and space (*VG = Virginia, MD = Maryland, NC = North Carolina, CBC = Christmas Bird Counts, AF-MWS= Atlantic Flyway -Mid-Winter Waterfowl Survey, BKB = Back Bay National Wildlife Refuge*)



Shorebirds — Refuge shorebirds include the sandpipers, plovers, dunlins, knots, yellowlegs, dowitchers, and sanderlings. They utilize the wet mud/sand flats and beach tidal habitats; where they search for the high-protein, invertebrate foods they need to sustain them during their exhausting migrations. They use the Back Bay Refuge beach and impoundments vicinities most during their spring and fall migrations. The Refuge draws down the water levels of its 880 acre impoundment complex to provide them with additional feeding areas during those periods. The most common species using the Refuge then are: the sanderling, greater and lesser yellowlegs, semipalmated sandpiper, semipalmated plover, short-billed dowitcher, snipe, black-bellied plover and willet. Lesser numbers of the spotted sandpiper, whimbrel, dunlin, red knot, western sandpiper, killdeer, and least sandpiper are also regularly seen then. Occasional sightings of the black-necked stilt and piping plover occur.

Gulls, Terns, etc. — Most birds in this group are found along the Refuge oceanfront beach during the spring and fall migrations, although several species venture further west into the impoundment complex and Back Bay. During the summer and winter, use of the Refuge by birds in this group declines sharply. Common species present during the spring and fall migrations include the ring-billed, laughing, herring, and great black-backed gulls, the royal, Forster's, Caspian, common and least terns, and the double-crested cormorant. Offshore, large numbers of common and red-throated loons, horned and red-necked grebes, northern gannets, and brown pelicans migrate through during the early spring of each year. Their migrations often coincide with food fish movements, to create an interesting feeding spectacle for birding enthusiasts. The brown pelican continues to roost on, and fly over, Refuge beaches throughout the summer

and fall; while the pied-billed grebe prefers to use shallow impoundments and backwater ponds/potholes within more interior wetlands.

Marshbirds — This secretive group of birds includes the rails, gallinules, moorhens and coot. Common Refuge residents include the king, Virginia and sora (during their migrations only) rails, the common moorhen, least bittern, and the American coot. Less common species include the purple gallinule and yellow rail. Marsh birds are surveyed in two Refuge areas during the spring and summer by an expert birding contractor, using an established FWS survey protocol. Surveys have been carried out in the Impoundment Complex and North Bay Marshes for the last 6 years to monitor rail and bittern population trends. Data reveal that large populations of least bitterns are using the wetlands around a canal that runs from Sandbridge Road to Hell Point Creek during their breeding season. There is a unique combination of Phragmites reed deadfall, resting atop black needlerush that results in an elevated "debris platform" throughout much of the area. This unique vegetative structure may encourage higher densities of these birds to nest here. In addition, this same area has moderate use by sora rails during the spring migration, but no use by this rail species during the nesting season. King rails are the most common rail species picked up in both the North Bay Marshes and the Impoundment Complex during these surveys.

Raptors — Common raptors on the Refuge include the following hawks: the northern harrier, osprey, American kestrel and sharp-shinned and Cooper's hawks. The red-tailed and red-shouldered hawks are occasionally present during the spring and fall migrations. Common owls are: the great horned and eastern screech. The most common raptors during the spring and fall migrations, are the sharp-shinned hawk and kestrel. An active bald eagle nest has existed, and fledged young, within the northern portion of Back Bay NWR since 1993. The osprey and northern harrier are the more numerous raptors at Back Bay NWR. The osprey nests on both artificial nesting platforms and nearby trees. Since the Bald eagle population began increasing in Back Bay during the late 1990's, there seems to be a reduction in osprey use of nesting platforms, and an increase in natural tree nests along bay shorelines. Whether this contributed to their loss of interest in platform use, as a result of the failed nests detailed in the following observations, or not, is unknown. Their breeding population had been fairly stable until 2001, when a sudden decline in the production of nest platforms production became apparent. Failures of nests with eggs and young in them were observed during June banding and final production checks, in 2001 and 2002. Predation by great horned owls and crows is suspected.

Passerines — Otherwise referred to as songbirds, this very large group of migratory birds includes the warblers, woodpeckers, sparrows, flycatchers, swallows, blackbirds, wrens, thrushes, vireos, and finches. The Refuge bird list provides a total of 155 passerine species that use Back Bay NWR. Point counts have been used to gather a baseline passerine population inventory and distribution information from the mid 1990s through 2003. These surveys revealed that Long Island supports one of the few breeding populations of seaside sparrows in this area; and that shrub-scrub habitats immediately west of the barrier island's sand dunes, support the highest density and diversity of songbirds during their spring migrations. Two bluebird trails provide limited support for nesting bluebirds south of Sandbridge Road, and prothonotary warbler nestboxes were placed on red maples of the Green Hills area to encourage nesting by this unique warbler. However, a 2004 cost-benefit analysis revealed that nestbox use by the bluebird and Prothonotary warbler was so low (1-3 nests per season), that it was not feasible to continue those nestbox programs.

Mammals

Common mammals that use Back Bay Refuge include the gray and red fox, raccoon, opossum, weasel, eastern cottontail and marsh rabbit, and white-tail deer. Common small mammals include the gray squirrel, rice rat, and a variety of mice, voles, shrews, and bats. The rare eastern big-eared bat is suspected to use Back Bay NWR habitats, however no sightings have occurred.

The mammal group includes nuisance species in addition to native wildlife species. Feral hogs, feral horses and the nutria are non-native species that have become residents of the Back Bay ecosystem. It is suspected that the feral hogs and horses are former domestic livestock that were allowed to roam free, or escaped, from the old, abandoned Village/Town of Wash Woods to our south (in what is now False Cape State Park, VA), and/or from Carova, North Carolina. The nutria has expanded its range into Virginia and Back Bay; although the existing population does not appear to pose as serious a threat to Refuge habitats, as it does in more northern states. Few muskrats are present. Some local residents feel that the nutria has displaced the native muskrat from its usual habitats in Back Bay. River otters are periodically observed within Refuge impoundments and Back Bay during most of the year.

Bobcats have been observed in the Black Gut woodlands, north of Sandbridge Road. One was struck by a vehicle and killed in 1994 on Sandbridge Road, and retrieved by Refuge staff.

Reptiles

The Refuge is home to a variety of reptiles, primarily snakes and turtles. Reptiles that are found on the Refuge include the rainbow, northern black racer, black rat, northern water, brown water, cottonmouth, smooth green, eastern kingsnake, eastern hognose, eastern garter, and ribbon snakes, which are common year-round residents here. The rare eastern glass lizard has been observed crossing the entrance road near the Refuge beach gate. Other common reptiles include the fence lizard and several skinks. The southern copperhead exists in the northern and western portions of the Back Bay watershed, including the Pungo and Charity Neck areas; and may also exist on the Refuge in suitable lowland habitats. The most numerous reptiles are the cottonmouth, black rat, northern water, brown water and hognose snakes.

Common terrestrial turtles include the eastern box, snapping, yellow-bellied, red-bellied, eastern painted, stinkpot, eastern box and eastern mud turtles. The yellow-bellied and snapping turtles are the most numerous species. The spotted turtle is suspected to be present in interior Refuge wetlands, although it has not yet been seen by Refuge staff. The Atlantic loggerhead sea turtle nests on Refuge and False Cape State Park beaches during its June through August nesting season.

A number of amphibians can also be found on the Refuge. This group of frogs, toads and salamanders includes such common Refuge residents as the southern leopard, the green, pickerel and bull frogs; the spring peeper, green and squirrel tree frogs; the eastern narrow-mouthed, southern and Fowler's toads. Information on salamanders is lacking; however, the red-backed salamander and two-toed amphiuma are known to exist on the Refuge. An amphiuma was accidently unearthed from muck next to a sign post during a Refuge maintenance project along the False Cape State Park border in the mid-1990s.

Three anuran frog and toad surveys were carried out during the spring and summer of 2001to 2003. Survey data reveal that the Refuge supports high numbers of the following frogs: the spring peeper, green tree, southern leopard, Brimley's chorus, green, and squirrel tree frogs; together with lesser numbers of the bull and carpenter frogs, and the narrow-mouthed, southern and Fowler's

toads. These surveys are part of a regional effort to monitor amphibian population trends on Region 5 National Wildlife Refuges, through use of a regional anuran survey protocol.

Fish

The impoundment complex supports a diverse and healthy fish community. The following species are most numerous in this 900 acre complex: largemouth bass, chain pickerel, bluegill/brim, redear sunfish, white and yellow perch, black crappie, brown bullhead, pumpkinseed, chub sucker, carp, American eel, bowfin, and a variety of bait fish.

The open waters of Back Bay and its tributaries support higher populations of carp, American eel, bowfin, flounder, brown bullhead, blue-spotted sunfish, white perch, warmouth, Atlantic needlefish, silversides, and longnose gar, than do the impoundments. Some largemouth bass, bluegill, pumpkinseed and pickerel also exist in the bay complex; but, in much lower levels than 25–30 years ago when SAV was more prevalent.

Efforts are made (during spring and early summer) to exclude spawning carp, longnose gar and bowfin, from entering the impoundments when exterior water control structures are open, through use of wire fencing sections placed over the pipe mouths on the bay side.

Invertebrates

Two state rare beetles (*Cicindela lepida* and *C. trifasciata*) and two rare moths (*Heterocampus astarte* and *Metria amella*) have been located on Refuge habitats. Both moths are associated with live oak trees. A third rare, live oak-associated moth (*Panopoda repanda*) is suspected to exist in this same vicinity, and has been seen in nearby False Cape State Park. The rare stripe-winged baskettail (*Epitheca costalis*) was observed in the Black Gut vicinity during a 1992 DCR-DNH Inventory (Clampitt, et al.1993) for the City of Virginia Beach.

Appendices C and D of "A Natural Heritage Inventory of the Back Bay National Wildlife Refuge" (Walton et al. 2001), provide listings of rare species created from observations and collections made at Back Bay NWR by DCR-DNH in 2000. However, none of these species has an official federal or state status.

The primary food of fish, shorebirds, some waterfowl (especially young), and amphibians are invertebrates. These include a variety of invertebrates that occupy the benthic soils below the water column, those that reside within the water column, as well as those in the air above the water and soil. Water column invertebrates include adult and larval insects (including *Diptera*, and *Hemiptera*), and crustaceans such as the scud (*Amphipoda*), isopod (*Isopoda*), copepod (*Copepoda*), and shrimp (*Mysidaceae*). Benthic invertebrates include: worms (*Oligochaeta*), clams (*Bivalvia*), snails (*Gastropoda*), some insect larvae (*Chironomidae* spp.), and small crabs (*Malacostraca-Decapoda*). All of these invertebrates are critical components in the food web of our wetlands areas, and merit consideration when planning land use changes.

Threatened or Endangered Species

Although no longer listed under the Endangered Species Act (but still protected under the Bald Eagle and Golden Eagle Protection Act and the Migratory Bird Treaty Act), the State threatened bald eagle uses the Refuge. The 1993 North Bay Marshes bald eagle nest was the first successful Back Bay eagle nest in recent history. Increasing numbers of juvenile eagles have been observed in tree-lines along the Back Bay shoreline during 2001 to 2003. Several new nests at Mackay Island NWR and on the North Landing River could be progeny of this first eagle nest.

During the past 15 years, the federally threatened Atlantic loggerhead sea turtle has deposited as many as nine nests each summer on Refuge and False Cape State Park beaches. In addition, occasional strandings of the Atlantic loggerhead, the federally endangered Kemp's ridley, green, leatherback and hawksbill sea turtles occur from May through September. Sea turtle stranding data is collected and passed on to the Virginia Aquarium's Stranding Center which maintains the local sea turtle and marine mammal stranding database.

The federally threatened shortnose sturgeon has been reported in Back Bay, but not confirmed. A specimen was reported in Refuge salvage records as collected in 1990, but a freezer breakdown resulted in its loss.

The federally threatened piping plover uses Refuge beaches during its spring and fall migrations, but to date has not nested here. The North Mile of the Refuge is closed to the public to allow this shorebird and others to use that section of beach undisturbed.

The federally threatened northeastern beach tiger beetle is not known to exist on Back Bay NWR; however, two other rare tiger beetles were discovered during a 2000 rare species inventory.

The State endangered eastern big-eared bat is suspected to use Back Bay NWR, but its occurrence has not been confirmed. The State threatened glass lizard was documented on Back Bay NWR during the late 1990s. Surveys were conducted during 2006 to document the extent of its presence on the Refuge; however, no specimens were located. One sighting occurred immediately southeast of the Refuge Headquarters, at the pipe gate, on February 25, 2007.

Wildlife and Animal Damage Control

Several Refuge wildlife species are considered non-native or feral in nature. The presence of such species often merits a problem or pest species status, particularly if the species presents a conflict with habitat management objectives or goals. Currently the following species fall into this pest species status: the feral horse, feral pig/hog, nutria and resident Canada goose.

The feral horse and feral hog are probably escapes/releases from human residents of the former town of Wash Woods that once existed in what is now False Cape State Park. The nutria has probably spread southward from states further north, where it was first introduced during the early 20th century. The Refuge year-round resident Canada goose population has gradually built up during the past 15 years, from 5-10 to about 35.

The feral hog, feral horse, nutria and resident Canada goose all consume moist soil vegetation being grown each year in the impoundment complex to feed wintering and migrating waterfowl. If too much browsing on this important resource is allowed to occur, the ability of the Refuge to provide wintering waterfowl foods will be severely reduced. Feral hogs also severely impact dike slopes and public use areas with their rooting behavior as they seek tubers and other foods below the surface of the ground. Such turned-over ground contributes to soil erosion around dike slopes, and creates a public safety hazard, while also removing the food-plants/vegetative cover. In addition, the Refuge has partnered with Virginia Department of Game and Inland Fisheries in a research study to better understand Refuge pig population dynamics and population size. The Study began in 2005, and is ongoing (2007). VDGIF has expended a great deal of time, funding and manpower to consistently and professionally collect and analyze the resulting data. Feral hogs feed on insect larvae, amphibian and reptiles as well, reducing population numbers and possibly affecting species diversity.

Such habitat management conflicts require remedial action to reduce the impacts. Often a culling of the population is necessary. In the case of feral hogs, the Refuge operates a one week hunt during which the public is allowed to hunt and remove these animals from the impoundment complex. This helps reduce the negative impacts until the population builds up once again.

The feral horse problem is being remediated by a cooperative effort between the residents of Sandbridge, VA, FCSP staff, and the Virginia Wild Horse Rescue, VA. A fence has been built at the North Carolina border in an attempt to keep the horses in North Carolina. If horses are found in the Park, Refuge or Sandbridge, the Virginia Wild Horse Rescue is contacted to remove the horses.

The resident Canada goose population increase is currently being handled by Refuge staff who are attempting to control nesting success in the impoundment complex from March through June. Nests are first visually located and subsequently visited. During the visit, the eggs are shaken and/or sprayed with cooking oil to keep them from hatching out. This program has had limited success due to the difficult nature of finding the hidden Canada goose nests. The Refuge applied for and received a FWS permit to remove adult resident Canada geese during the nesting season in the Refuge impoundment vicinity during 2005. Several geese were removed in 2006. This egg addling and adult removal control effort will continue until the Canada goose ceases nesting in the impoundment vicinities.

The nutria has not been as significant a problem here that it has been further north in Maryland and Delaware. We suspect that the water management regime in the impoundment complex (drawing down in the spring and summer, and flooding during the fall and winter) prevents their numbers from building up. We think that their populations are forced to disperse into Back Bay during the draw-down periods, where they are more prone to predation and less hospitable conditions that result in mortality. Impoundment habitats have not experienced noticeable nutria eat-outs to date. It is possible that if the impoundment complex was flooded year-round, that nutria eat-outs would occur, and impoundment habitats would be negatively impacted. No control efforts to date are necessary for the nutria.

Insects and Diseases

The following pest insects and wildlife diseases have occurred in this vicinity, or are near enough to be concerned about it spreading into our geographic area, since the end of the twentieth century. Guidance on how to deal with all possible wildlife diseases (well-known waterfowl diseases, Highly Pathogenic Avian Influenza, West Nile Virus, Eastern Equine Encephalitis and Chronic Wasting Disease) is now provided in one Refuge "Integrated Disease Plan," that was completed in early 2007.

Southern Pine Bark Beetle— This pest focuses principally on loblolly and shortleaf pines; although very little shortleaf pine exists in the Back Bay vicinity. Although this is probably the principal beetle pest in this area, other bark beetles also exist and may inhabit the same tree, and thereby combine to kill the host pine tree (Thatcher and Connor 1985). Control on the Refuge consists of cutting and removing the infested trees and a buffer of uninfested trees, and letting the cut trees lie ("cut and leave"). This technique is recommended by Swain and Remion (1981) in their booklet, "Direct Control Methods for the Southern Pine Beetle." The beetle larvae seem to require upright, live trees to mature in; since they die when the trees are cut and left in a horizontal position. Two "spotty" outbreaks occurred during the past fifteen years in the Sandbridge Road vicinity during the 1990s; however nothing more recent has occurred.

Gypsy Moth — This insect pest has the potential to defoliate live oak, other oaks and deciduous trees. Current policy consists of cooperating with the U.S. Department of Agriculture in monitoring and controlling an existing population in False Cape State Park, in the North Carolina border vicinity. Where no human impacts are involved, Refuge policy is to allow their populations to peak and crash naturally. When their populations reach the peak level, they are known to be infected with a virus that virtually wipes them out without human control efforts necessary. This has been shown to be an effective management policy. No known concentrations currently occur on the Refuge.

Eastern Tent Caterpillar — These caterpillars are regular users of the Refuge whose populations peak and crash on their own, without control efforts required. Natural predators and other natural mortality factors successfully control their numbers. They occasionally defoliate black cherry and other deciduous trees, but rarely cause mortality to infested trees.

Mosquitos — West Nile Virus (WNV) & Eastern Equine Encephalitis (EEE) can occur in people and horses. WNV often first appears in birds. The common and fish crows, blue jay and several hawks, serve as the principal sentinel species that appear to register outbreaks first. A number of mosquito species (six *Culex* spp., including the common house mosquito *[Culex pipiens]*, as well as *Aedes albopictus, Ae. vexans* and *Ochlerotatus triserius*) are the principal vectors for WNV. The *Culiseta melanura* mosquito is the only known vector in this area for EEE.

During 2004 to the present (2007) Refuge biological staff worked closely with City of Virginia Beach Mosquito Control biologists during monitoring of Refuge mosquito populations for WNV outbreaks. To date no cases of either WNV (in birds or humans) or EEE are known to have occurred on the Refuge or in the Refuge vicinity. As a result, no mosquito control work has been necessary in Refuge habitats.

Other biting flies — Principally dipterans (*Tabanidae* family) are a nuisance, but necessary since as both adults and larvae, they serve as critical invertebrate foods to numerous migratory bird and insect species. Because they are a critical component in the Back Bay ecosystem and food-chain, Refuge populations are not currently controlled.

Avian cholera — This avian disease occasionally surfaces in wintering diving duck populations using the Atlantic Ocean and Chesapeake Bay. It last occurred during the winter of 1992-1993. Species impacted were scoters, oldsquaw and some gulls. Management consists of removing dead birds along shorelines to reduce the contagious nature of the disease, and disposing of the carcasses at the local City Animal Control facility's incinerator.

Chronic Wasting Disease — During 2005 – 2006 this Cervid disease recently spread into deer populations in New York and West Virginia. It threatens to spread into western Virginia. However, to date, CWD has not yet occurred in Virginia.

Non-native Organisms

During 2002 and 2003, Region 5 refuges embarked on an invasive species mapping effort aimed at identifying and quantifying the acreages of pest invasive species. Back Bay NWR joined that effort during 2003, when it received Regional funding enabling it to hire field support by qualified technicians with Trimble GPS units. Regional protocols were obtained, together with a listing of invasive plant species. Of that listing, 13 plant species were identified as currently existing on Back Bay NWR. The top three priority species are common reed, Japanese

stiltgrass/eulalia and Johnson grass. These three non-native invasive species were mapped, and control work consisting of the application of herbicide would continue until their presence is greatly reduced or eliminated.

Other non-native species listed include: Japanese honeysuckle, morning glory, Asiatic dayflower, giant foxtail, Asiatic sand sedge, Eurasian water-milfoil, parrot-feather, fennel, shrubby bush-clover/lespedeza, weeping lovegrass and yellow iris/flag. Although these species are present on Back Bay NWR, they do not pose a significant threat, because they provide benifits to resident wildlife, and do not appear to significantly compete with other resident species for the ecological niches they share, or occupy, in their respective habitats. However, their locations will be eventually mapped and their populations tracked when possible.

Dr. Kristin Saltonstall, of the University of Maryland Center for Environmental Science's Horn Point Lab, and her associate Robert Meadows of the Delaware Division of Fish and Wildlife, have discovered several native strains of Phragmites in North America that are not as invasive as the more common non-native species. These experts have recommended that the native Phragmites populations be left intact. Back Bay NWR biologists are capable of identifying both the native and invasive strains. Several populations of the native Phragmites strain were discovered on the Mackay Island NWR, Knotts Island by Back Bay NWR Biologist John Gallegos in 2004. Samples were collected and subsequently confirmed by Dr. Saltonstall. Mr. Meadows subsequently visited this area with Biologist Gallegos and mapped the native Phragmites sites on Knotts Island. He also participated in a boat survey of most of Back Bay, including part of the North Bay Marshes, in search of the native strain. We suspect that because of the native strain's preference for quieter, oligohaline waters, some exists on Back Bay NWR—especially in the Long Island, Bay island complex, North Bay Marshes and Black Gut vicinities—as well as False Cape State Park. However, that boat survey failed to reveal any sign of the native strain.

Socio-Economic Factors

Setting

Virginia Beach City is in the southeastern corner of Virginia with the Atlantic Ocean to the east, Currituck County, North Carolina to the south, the cities of Chesapeake and Norfolk, Virginia to the west, and the Chesapeake Bay to the north. Land use patterns divide the City into three sections. The northern section is the higher density urban and residential region. The southern section is the rural region. The mid section or "Princess Anne Transitional Area" provides a mixed density transition between the urban north and rural south. The boundary between the urban north and Transition Area is known as the Green Line. Back Bay partially bisects the City from the south in an east-west direction, with North Landing River and Back Bay's bay complex being the primary water areas.

Back Bay NWR is located in the eastern half of the rural southern section of Virginia Beach. The Refuge is bounded to the east by the Atlantic Ocean, to the south by False Cape State Park and Back Bay, to the west by rural land, to the northwest by the mixed density Transitional Area, to the north by Lake Tecumseh and to the northeast by the Sandbridge residential resort community.

Virginia Beach has been one of the fastest growing cities in the U.S. for several decades. However, developable land in the urban north has dwindled, thus putting pressure for new growth south of the Green Line. Significant land use changes adjacent to Back Bay NWR could occur with further development in the Transitional Area and incursion of residential development into the rural southern region.

These potential land use changes form a significant part of the Virginia Beach 2003 Comprehensive Plan and provide a decision making crossroads for the City with respect to the type, location, and amount of growth. The Plan acts as a guide rather than a land use law. The Comprehensive Plan calls for retaining the rural character of the southern region while allowing moderate growth in the Transitional Area. Back Bay NWR and the rural nature of the southern area are compatible uses and are planned as such.

Population

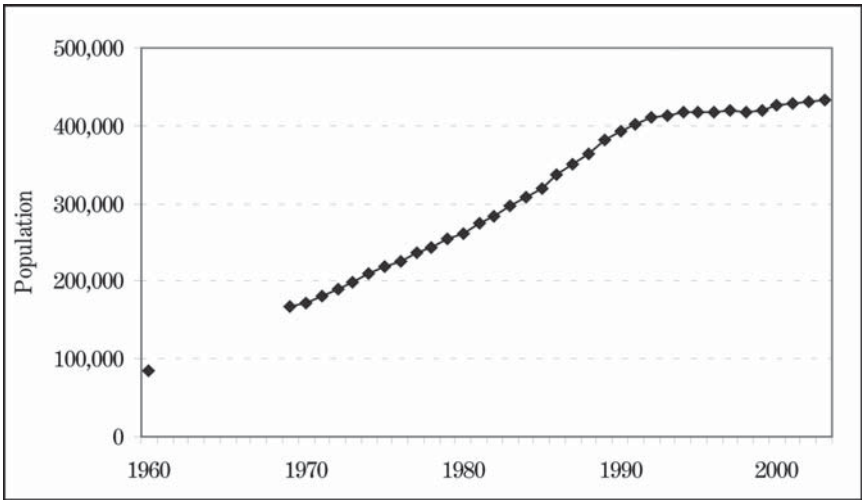
The population of Virginia is about 7.1 million. Approximately one fifth of the State, or 1.5 million, live in the Norfolk-Newport News-Virginia Beach ("Tidewater" or "Hampton Roads") Metropolitan Statistical Area located in the south-eastern corner of the State. The metropolitan area consists of the cities of Virginia Beach, Chesapeake, Portsmouth, Newport News, Norfolk, and Hampton, with Virginia Beach the largest city with 425,257 (U.S. Department of Commerce 2000).

Much of the growth is attributed to the military presence as well as being a resort community. Table 3.4 indicates this tremendous amount of growth. (In 1963 the County of Princess Ann and Virginia Beach merged to form the City of Virginia Beach) The growth rate since 1990 has begun to slow as the amount of developable vacant land in the northern urban-suburban area declined (City of Virginia Beach 2003), as well as a decline in the birth rate (Hampton Roads Planning District Commission 2002). A comparison of the 1960–2003 population data (Figure 3.19) with the 1959–2003 data on farmland acreage (Figure 3.20) indicates the stark contrasting pattern of increasing population and decreasing farm land-use in the City.

Table 3.4. Virginia Beach population trends

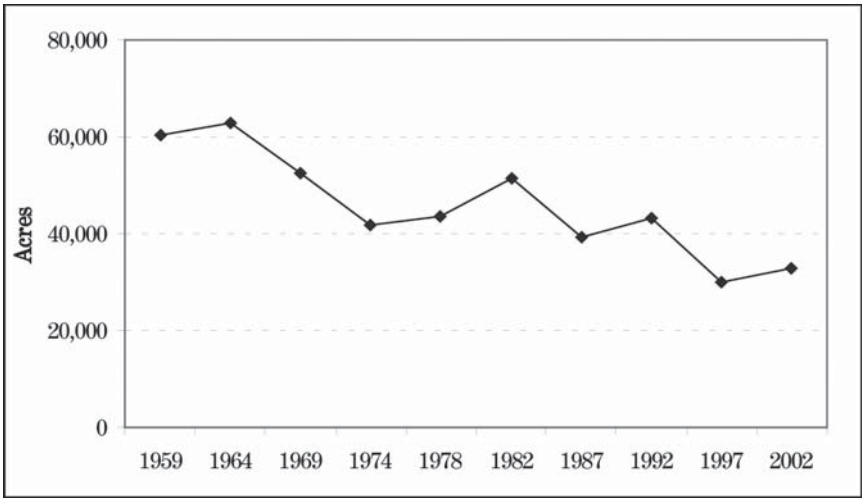
Year	Population	Population Growth	Growth Rate
1940	19,984	-------	-------
1950	42,277	22,243	111%
1960	84,215	41,988	99%
1970	172,106	87,891	104%
1980	262,199	90,093	52%
1990	393,069	130,870	50%
2000	425,257	32,188	8%
2003	433,000	7,743	10%

Figure 3.19. Virginia Beach population trends, 1960-2003



(Sources: U.S. Department of Commerce, Census Bureau; Virginia Beach Facts and Figure, 2003)

Figure 3.20. Farm Acreage within Virginia Beach between 1959-2002



(Sources: U.S. Agricultural Census; Virginia Beach Magazine, Winter 2003-2004)

The population is 71.4 % White, 19.0 % is Black, 4.9 % is Asian, 4.2 % is Hispanic, and 0.4 % is Native American (U.S. Department of Commerce 2000). Adjoining cities in the metropolitan area have a significantly higher percent African-American population.

The 2000 census population age distribution is unusual in that the median age, 32.7, is fairly young. Slightly more than one third of the population is under the age of 25, nearly one half is between the age of 25 to 54, while only 16% is over the age of 55.

While one half of the 2000 census population had lived in the same dwelling for the previous five years, there is a segment of the population which can be considered mobile or recently immigrated. One fifth of the 2000 census residents had lived in another state in 1995. Part of this may be due to the relocation to Oceana Naval Air Station of military personnel after the closing of the Cecil Field, Florida, Naval Air Station in 1999.

Employment

For several decades military installations have provided the predominate employment base in Virginia Beach (Table 3.5). The four military bases have an approximate annual payroll of $1.1 billion for 35,000 armed services and civilian workers (U.S. Department of Commerce 2003). Since 1970 total armed service employment has remain moderately stable at about 25,000, with a peak of 29,000 from 1989-1991 (Hampton Roads Planning District Commission 2002). However, due to the enormous growth of the total employment base of Virginia Beach, military percent of total employment has declined from 40% in 1970 to 10% in 2000. Local government and education provide the next highest categories of employment in Virginia Beach.

Table 3.5. Virginia Beach Military Employment

Installation	Active Duty	Civilian	Total	Payroll (million)
Oceana	13,000	2,100	15,100	$600
Little Creek	7,700	5,200	12,900	$232
Fort Story	1,500		1,500	$70
Dam Neck	5,000		5,000	$224

Oceana Naval Air Station is the Navy's largest Master Jet Base and is home to most of the F/A-18, Hornet Squadrons on the East Coast. Little Creek Naval Amphibious is the largest of its kind in the world and is the major operating base for the amphibious forces of the U.S. Atlantic Fleet. Fort Story is the Army's Logistics-Over-The-Shore training and test site. Dam Neck Fleet Combat Training Center provides operation and employment of combat direction and control systems.

There are a number of other major employers. Table 3.6 lists employers with at least 1000 employees (U.S. Department of Commerce 2003; Hampton Roads Economic Development Alliance, 2004)

Table 3.6. Virginia Beach Employment

Employer	Industry	Employees
Virginia Beach Schools	Education	9,600
Virginia Beach City	Government	5,000
AMSEC LLC	Naval Engineering	2,300
Manpower	Human Resources	1,800
Lillian Vernon	National Catalog Distribution Center	1,700
GEICO	Automobile Insurance	1,600
Gold Key Resorts	Resort	1,600
Stihl	Outdoor Power Equipment	1,300
Amerigroup	HMO Provider	1,150

Tourism provides another major, but seasonal, component of employment. This water oriented industry is one of the largest in the country with 28 miles of public beaches. The resort industry contributes $700 million to the local economy on an annual basis with 3 million visitors (U.S. Department of Commerce 2003).

Income

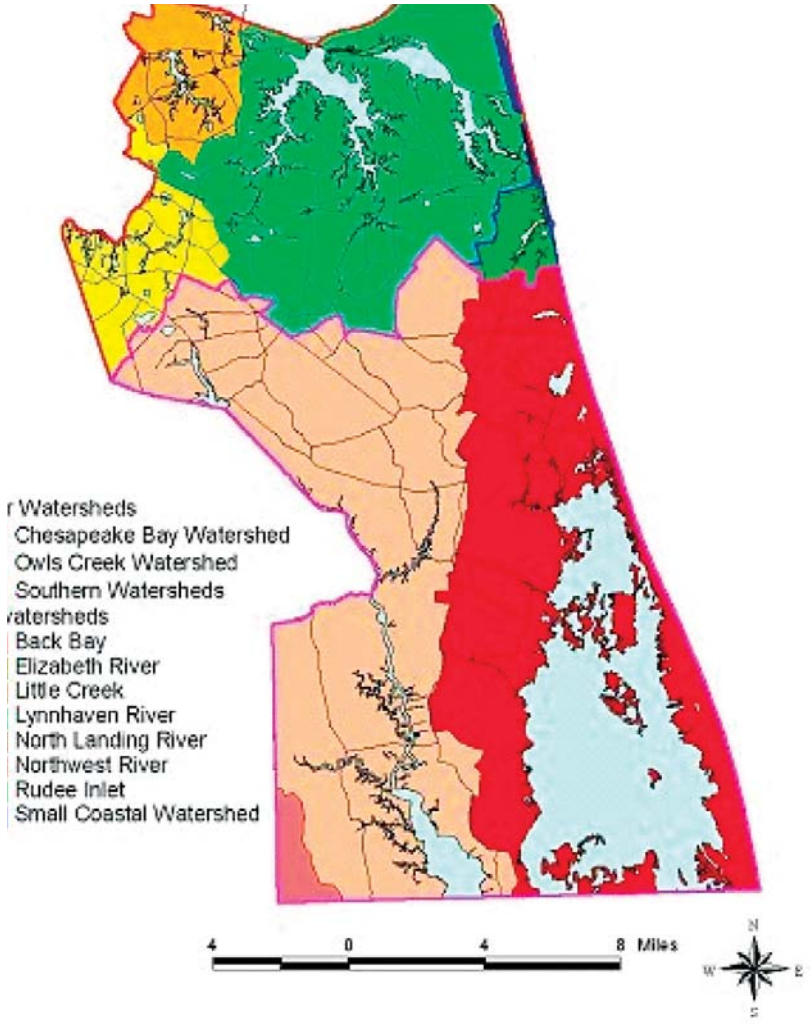
In 2004 the median family income was $53,540. This ranked Virginia Beach as the fourth highest in the nation, (U.S. Department of Commerce 2004). Cost of living is relatively low, slightly below the national average, thus causing high purchasing power for the area.

The 2000 poverty rate was 6.5 % of the population, well below the state average of 9.6 % (U.S. Department of Commerce 2000). The unemployment rate in January, 2004 was 3.5 %, slightly below the Commonwealth of Virginia unemployment rate of 3.9 %, and well below the national rate of 5.8 % (Virginia Employment Commission 2004).

Land Use

Virginia Beach is a level to gently rolling, near sea level, urban community bordering the Atlantic Ocean. Of its 259 square miles twenty percent, 51 square miles, is water. Maximum inland non-beach dune elevation is 25 feet. Back Bay NWR, 14 square miles or 9,035 acres, is located in the southeastern corner of Virginia Beach within the Back Bay watershed. The interior of the watershed is water. Around the periphery of water are lowland wetlands, much of it protected by various public entities. The outermost uplands of the watershed are developed residential, farmland, and barrier sand dunes (Figure 3.21).

Figure 3.21. Virginia Beach Watersheds (Source: City of Virginia Beach 1999)



The 2003 Virginia Beach Comprehensive Plan describes existing land uses and proposed changes in the future as a guide to growth. The urban-suburban northern area has dwindling acreage for development. From 1997 to 2003 the number of acres declined from 13,000 to 5,000. The challenge for the City is how and where to channel new growth. One alternative would be to redevelop existing developed land in the northern area.

Another land use alternative would be to develop extensive vacant land in the southern area below the Green Line. Three locations adjacent or within Back Bay NWR were singled out for consideration in the Plan and have land uses which impact Back Bay: Sandbridge, Princess Anne Transitional Area, and Rural areas.

Sandbridge borders northeastern Back Bay. It is an elongated, narrow barrier island between the Atlantic Ocean and Back Bay. Sandbridge is a low density,

single family and mid-rise condominium apartment summer resort community of about 1200 dwelling units with a neighborhood commercial center. The plan calls for retaining the existing, low density character of Sandbridge and for land uses compatible with the environmental objectives of Back Bay NWR.

The area which could have the greatest proposed land use change adjacent to Back Bay NWR is the Transition Area northwest of the Refuge. The northern boundary of the Transition Area was designated in 1979 as the Green Line in the City's first Comprehensive Plan. The original intent of this administrative line was to divide the city into the urban north and rural south. The later creation of the Transition Area now divides the City into three zones of density. The Transition Area (renamed as the Princess Anne area) was formerly the Princess Anne County government seat before it merged with Virginia Beach in 1963.

The Transition Area is considered to be mixed use, mixed density. One of the primary objectives of the Comprehensive Plan is to keep this area as a transition between the urban northern and rural southern parts of the City. To this end half of the land is planned as an integrated greenway system with preservation of natural resources, open space and recreation. Development potential is purposely kept low. However, due to the fact that developable land still exists, significant growth can occur. Such growth would include low to mid-rise offices and corporate parks, light industry, and limited retail. Another proposal is for the creation of the Southeastern Parkway to traverse the area in a northeast to southwest direction.

The area south of the Transition Area is designated as the Rural Area. Back Bay NWR is located in the easterly portion. The Rural area lies south of Indian River Road from North Landing Road and extends to the North Carolina border. It covers 138 square miles, close to half of the total area of the City. The primary land use of this area is agriculture, wetlands, water, and isolated residential. Back Bay and North Landing River bisect a narrow three by twelve mile, north by south, swath of low-lying upland.

Lack of city services, such as sewer and water, and poorly drained soils limit the development potential of this area. The Comprehensive Plan calls for very limited growth in this area. Residential densities would be kept very low (5-15 acres per dwelling unit) with preservation of agriculture and wetlands. Throughout the 1980's and 1990's the average residential annual growth was about 30 dwellings per year. Of primary importance to Back Bay NWR is whether or not developmental pressures in the Rural Area are significant enough to counteract the intent of the City's Comprehensive Plan.

Back Bay NWR does not exist in isolation with respect to protected open space. Regionally, the largest nearby refuge is the 110,000 acre Great Dismal Swamp NWR that straddles the Virginia – North Carolina border 25 miles southwest and west of Back Bay, Virginia Beach. Just south of Back Bay NWR is Mackay Island NWR. This Refuge also straddles the Virginia – North Carolina border, with about 1,000 of its 9,035 acres located within Virginia Beach. The Nature Conservancy manages the North Landing River Preserve. The Preserve is one of the largest expanses of undisturbed freshwater marsh habitat along the entire eastern seaboard. Approximately 2,700 of its 7,500 are within Virginia Beach, with the remaining acreage located west in the city of Chesapeake.

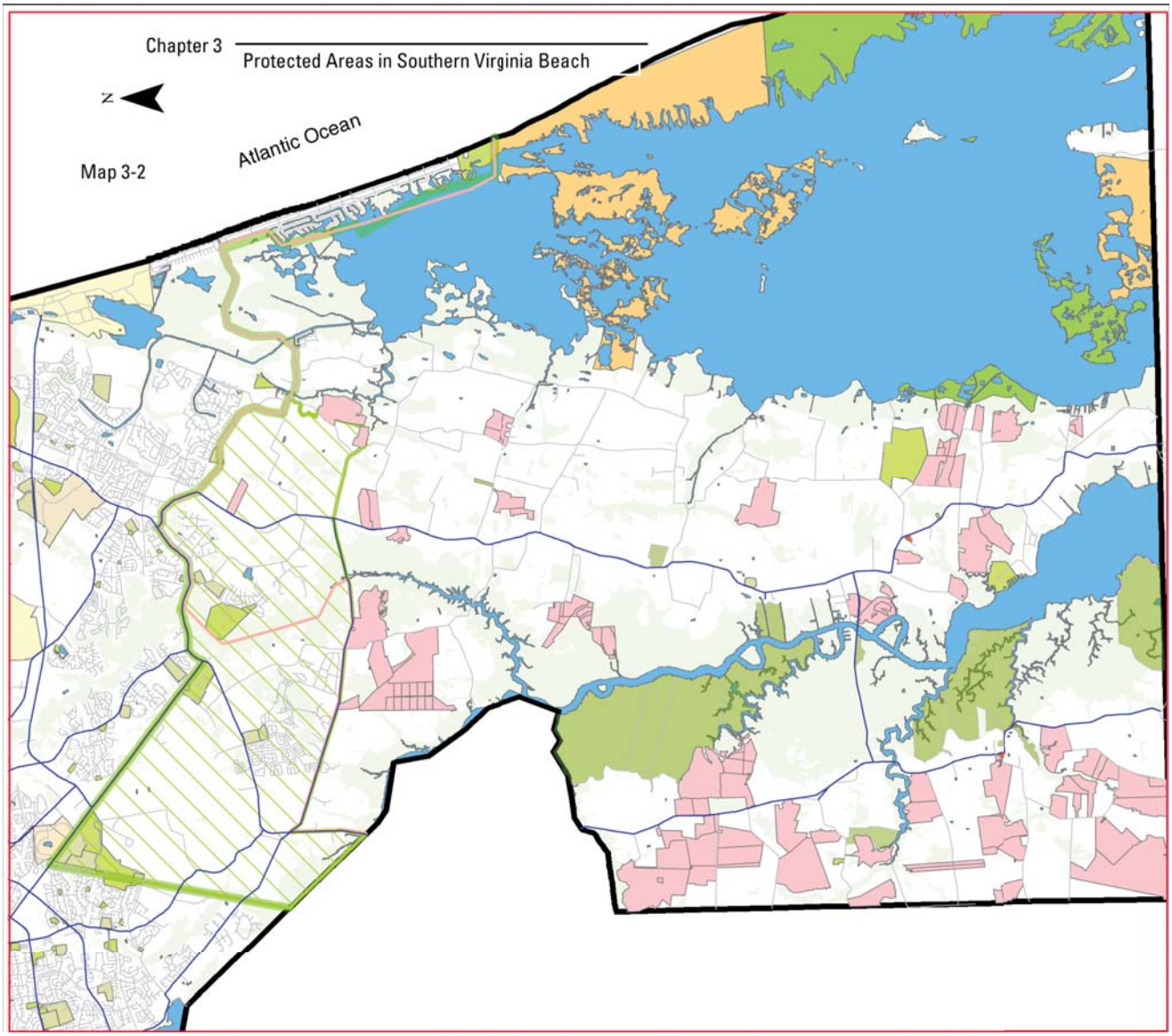
Within Virginia Beach there are adjoining open space areas owned or managed by various entities. Table 3.7 lists estimates of major acreage. The map below indicates the location of major open protected areas in southern Virginia Beach (Map 3-2). The map underestimates the extent of Back Bay NWR. The most striking aspect is that about two thirds of southern Virginia Beach is water or protected open space.

The Virginia Beach Agricultural Reserve Program (ARP) was established in 1995. It includes lands already actively being farmed, but through transfer of development rights will remain open space; rather than potentially being developed. Final ARP increases in acreage would total 20,000 acres of the current 30,000 acres being farmed. By early 2004 the total ARP acreage was 6,775. Approximately 500-1,000 acres are being added per year to the ARP.

Table 3.7. Virginia Beach Open Space – approximate acreage (w/ adjoining regions)

Sites	Acres
Open Water	33,000-48,700
Agriculture	30,000
Virginia Beach Agric. Reserve	6,775
Back Bay NWR	9,035
Mackay Island NWR (NC/VA)	[8,000]
False Cape State Park	4,320
The Nature Conservancy – N. Landing R.(VB/CH)	[7,500]
Princess Anne Wildlife Mgt. Areas	1,500
Little Island Park	150

Map 3-2. Protected Areas in Southern Virginia Beach



Archaeological and Historical Resources

The only large scale archaeological survey done on the Refuge, by R.C. Goodwin & Associates, identified 24 archaeological sites. The majority of information in the following narrative is derived from the text of that report (Goodwin 1989). Five additional sites have been found since 1989. Many sites on the Refuge contain material from more than one time period, revealing repeated use over several centuries. Of the 29 total sites, 10 have Native American material dating from prior to European contact, 14 have material associated with historic period farms on various islands as well as on the western shore of the bay, and 9 have material associated with historic hunting clubs.

Pre-Contact Sites

Human occupation in Virginia appears to have begun in what archaeologists call the Paleo-Indian period (ca. 14,000 to 9,000 years ago). However, the oldest sites identified on the Refuge date to the Early Woodland period (ca. 3,000 to 2,500 years ago), and sites dating prior to that appear to be rare in the Refuge vicinity. Several causes have been posited for this lack of evidence for earlier sites. Sea level rise and erosion were fairly rapid during the preceding Archaic periods (ca. 9,000 to 3,000 years ago), hindering development of shellfish beds until near the end of that period. However, following sea level stabilization in the Early Woodland, shellfish became a substantial component of the bay's aquatic environment, and the majority of pre-Contact sites on the Refuge contain shellfish remains. Some researchers have posited a locally low human population in the Archaic, feeling that absence of shellfish may have made the area unattractive for settlement. Submergence of sites under saltmarsh in areas of relatively quiet water, and erosion of those in more exposed areas during Archaic sea level changes may also have destroyed Archaic and Paleo-Indian sites or hidden them from our view.

Following centuries of relative stability, sea level rise has once again accelerated remarkably in recent decades. As during the earlier marine transgression, sea level rise may have submerged relatively intact sites in sheltered settings beneath several feet of tidal marsh, but such sites are extremely difficult to find except through accidental discovery. In areas exposed to storm surges or persistent wind driven waves, erosion has probably destroyed sites. Such areas are common on the islands and shores of the bay as well as along the entire seafront of the barrier beach. Every one of the identified pre-Contact sites and the vast majority of Historic Period sites in the Refuge were identified by Goodwin as experiencing substantial damage or loss from erosion. Some sites reported by Goodwin's researchers may have completely washed away in the nearly 20 years since that study. Finally, lack of sites predating the Woodland period may partly reflect the fact that there have been relatively few archeological surveys in the Refuge and its immediate area when compared to other parts of the state.

Sites on the Refuge dating from the Early Woodland (ca. 3,000 to 2,500 years ago) and Late Woodland (ca. 1,000 to 400 years ago) are most easily differentiated by distinctive pottery types relating to each time period, but appear to share a reliance on shellfish as a major part of the Native American diet. No Middle Woodland sites (ca. 2,500 to 1,000 years ago) have been found in the Refuge, but several sites show signs of both Early and Late Woodland occupation. The absence of identified Middle Woodland artifacts at those sites is probably due to the very limited archaeological research on them, rather than due to the sites being actually abandoned during the Middle Woodland.

As noted above, some of the sites reported by Goodwin in 1989 have probably been lost to erosion, but others probably still have significant research potential, due to good preservation of shellfish, finfish, and other materials that could provide substantial data on how Native Americans lived on the land and harvested its resources over the course of several thousand years. Goodwin

reported that some of these sites are known to artifact collectors, but the extent of looting damage to them is unclear.

At the time of Goodwin's study, no refuge lands had been acquired on the western shore of the bay. Prehistoric sites are likely in many areas there, both within the current Refuge and within its acquisition boundary. Several small surveys have been performed by Service archaeological staff for wetland restoration projects in former croplands on that part of the Refuge. One pre-Contact site, of uncertain date, was identified in such a study and was subsequently preserved by redesign of the project to avoid it.

Historic Sites

A patent was issued for a portion of two bay islands in 1675, but no additional island patents are recorded until the early 18th century. Goodwin's discovery of early 18th century pottery at a site on one island that also contains pre-Contact material may indicate either Euro-American settlement on the earlier site, or a continuation of occupation by Native Americans. The name "Trading Post" given to an 18th century patent on one of the other islands may reflect their continued presence.

Reference to a house and other farm structures in a 1711 title record demonstrates that Euro-American settlement was established on at least one of the other islands before 1711, and farms were established on other islands around that same time. Most of the island farms appear to have operated until the final decade of the 19th century. Along with dwellings, outbuildings, livestock enclosures, pastures, and orchards, these farms included a network of bridges, canals, and landings necessitated by their unusual setting. A family cemetery was established on at least one island prior to 1868. Little research has been done on these rather unusual farmstead sites. A program of historical and archaeological study could yield insight into their economic base as well as social status of their occupants, some of whom were landowners and some tenants. As with pre-contact sites on the bay, erosion is taking a severe toll on these sites.

In the last decade of the 19th century, most of the bay islands and barrier beach became property of three large waterfowl hunting clubs. Two large clubhouses formerly stood within the Refuge, one on an island and the other at the approximate location of the current Refuge office. Early 20th century maps show a system of gated channels and guard shacks constructed by the clubs to deter poaching, but those appear to have left little or no archaeological evidence. A donated collection of waterfowl hunting equipment, partly on display at the Refuge, testifies to waterfowl hunting on the bay.

Maritime archaeological resources may be fairly substantial on the Refuge and immediately offshore, as numerous shipwrecks are recorded having grounded on the barrier beach. Actual discovery of abandoned and wrecked vessels is usually subject to vagaries of weather, and only a few have been reported to Refuge staff and studied by maritime archaeologists. Study of the design of one vessel wreck established that it was a two masted schooner built in the early 19th century, formerly a commonplace type of vessel, but a type that is seldom available for study today in maritime museums.

As noted earlier, the Goodwin study did not cover lands within the acquisition boundary or currently in the Refuge on the western side of the bay. No published archaeological or historical overview exists for that part of the Refuge. Poor drainage hindered settlement of the west shore of the bay nearly as much as on the islands, and no patents are recorded until the last quarter of the 17th century. Settlement consisted mostly of small farms from the time of initial settlement until

the onset of 20th century suburbanization. Five farmsteads dating from the early 19th to the early 20th century, as well as a small family graveyard, were identified as a result of minor archaeological and historical studies by Service staff.

Historic Structures

While no standing structures of the 17th or 18th century remain within the acquisition boundary, the area does reveal a scattering of 19th and early 20th century farm buildings interspersed with modern residential development. There are currently no above-ground historic resources on the Refuge itself. Historic structures eligible for inclusion in the National Register of Historic Places may exist within the acquisition boundary and could be inadvertently acquired by the Refuge along with surrounding farmland.

A small farmhouse was acquired in exactly that manner by the Refuge in the early 1990s. As it was in extremely deteriorated and vandalized when it was acquired, demolition was proposed. Much of the vandalism appears to have been related to a belief that it was the home of Grace Sherwood, notable for her trial under accusation of witchcraft in 1706. However, research firmly established that the house was actually built around 1822 and was probably not even on any property that had been part of Grace's farm.

Consultation with the Virginia Department of Historic Resources (DHR) did confirm that the house was an historic structure of unusual design for its time and place. DHR and Service staff performed an initial study of the house, involving photographs, sketch plans, and historic research. That study revealed its antebellum owners as "middling planters" and slave-owners with unusually extravagant taste in clothing, carriages, and architectural decoration. Plans for stabilization and historic interpretation of the structure were then explored. However, despite considerable effort by Refuge law enforcement staff, the house fell victim to arson shortly before funds were actually approved for its repair.

Refuge Management & Use

Land Acquisition History

As of 2007, Back Bay Refuge contained 9,035 acquired acres within the official Refuge Land Acquisition Boundary. The Refuge is located within the City of Virginia Beach and was established by Federal Executive Order in 1938. Not including open water, the original Refuge land area contained 4,589 acres. For the next half century no additional land acquisition occurred. In 1989 an Environmental Assessment proposal was put forth to acquire additional land west and north of the original Refuge boundary. This would expand the boundary and more than double the size of the Refuge to 11,000 acres. The purpose of the expansion was to provide long-term protection of wildlife habitat and water quality, as a result of potentially threatening urban development into the rural environment of the Refuge. Land acquisition began in 1991 at the rate of about 350 acres per year, though the largest portion of the expansion occurred by 1993.

Staffing and Budgets

As of 2007, Back Bay NWR had thirteen full-time staff positions. The organizational chart (see page E-1) indicates type and relationship of positions.

Table 3.8 indicates permanent staff, operations and maintenance budgets over the past eight years. Since 1997 staffing has remained relatively stable at 12 Full time employees. The high 1996 Full time employees relates to unfilled vacancies within the organizational chart. 2003 staffing consists of twelve permanent employees:

Table 3.8. Refuge budgets from 1996 to 2006

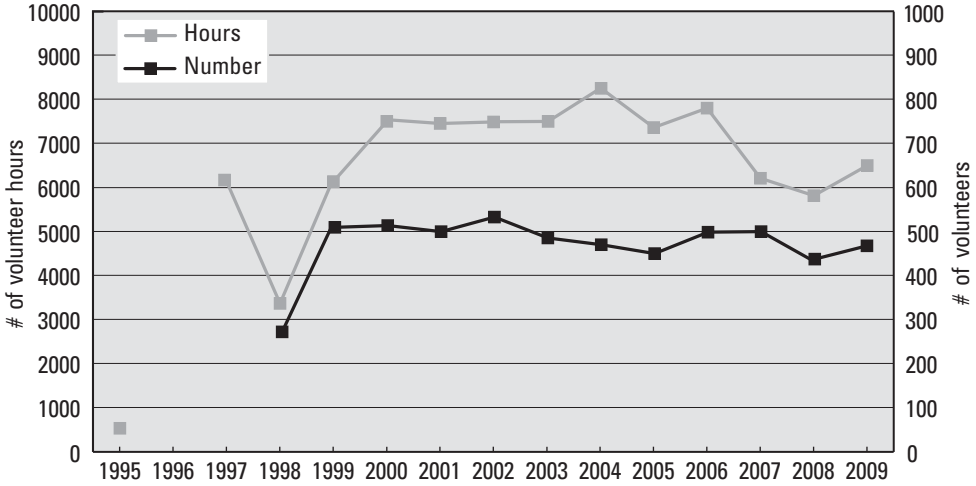
Year	FTE	Operational Funding	Maintenance Funding
1996	20.3	$604,100	$100,000
1997	11.4	$582,900	$49,100
1998	11.8	$646,000	$81,300
1999	12.8	$748,100	$70,000
2000	13.2	$803,300	$241,000
2001	13.6	$840,400	$697,000
2002	12.6	$876,700	$85,800
2003	13.0	$1,095,405	$504,421
2004	13.0	$1,093,328	$339,369
2005	13.0	$1,363,832	$339,345
2006	13.0	$1,034,775	$503,720

Operations funding includes those funds used for such things as salaries, new purchases, contracts, and new construction. Since 1996, there has been a steady increase in operational funding. These increases mostly reflect increased fixed costs and salaries. In 2003 an additional $213,000 Refuge Operations Needs system (RONS) project went for the Horn Point canoe launching facility.

Maintenance funding is used for maintaining existing infrastructure. Prior to 2000, maintenance funding was usually less than $100,000 per year. In 2000, 2001, and 2003 there were large outlays for maintenance. In 2000, they went for dredging, a bulkhead study, and a beach access ramp. In 2001, they went to replacing a front-end loader, dozer, farm tractor, and radios. In 2003, they went for a boat ramp and replacing a bulkhead. Since 2003, annual maintenance funding has remained above $300,000.

Past records on volunteer assistance toward Refuge operations indicate a dramatic increase in the number of volunteers and hours from 1998 to 2000, with a steady average of nearly 500 volunteers and 7,650 hours (Figure 3.22).

Figure 3.22. Total Number of Volunteers and Volunteer Hours between 1995-2009



Refuge Revenue Sharing Payments to Counties and Towns

Back Bay NWR contributes directly to the Virginia Beach economy. Since 1935, the U.S. Fish and Wildlife Service has made Refuge Revenue Sharing payments to counties or towns for refuge land under its administration. Lands acquired by the Service are removed from the tax rolls; however, under provision of the Refuge Revenue Act the local unit of government receives an annual revenue sharing payment. This amount may equal or exceed the amount that would have been collected from property taxes if it had been held in private ownership.

Table 3.9 indicates the amount paid to Virginia Beach from 1981 to 2003. Since 1993 Refuge lands have been appraised between $5,000 to 6,000 per acre. This has brought in roughly $200,000 revenue sharing dollars per year, although this amount has been declining over the past decade. The peak payment amount occurred in 1994, at $269,771 and declined to $172,686 in 2000.

Table 3.9. Refuge Revenue Sharing Payments to City of Virginia Beach, 1981–2007

Year	County Payment
1981	109,867
1982	----------
1983	96,589
1984	
1985	173,697
1986	162,082
1987	159,105
1988	191,834
1989	210,102
1990	252,583
1991	250,512
1992	----------
1993	269,082
1994	269,771
1995	201,681
1996	224,636
1997	207,032
1998	198,732
1999	186,001
2000	172,686
2001	182,178
2002	183,917
2003	177,716
2004	157,256
2005	179,661
2006	168,861
2007	$165,907

Refuge Infrastructure

Established in 1938, Back Bay NWR has established a significant infrastructure to support the Refuge mission and purposes. This infrastructure includes roads and parking areas, buildings, trails, water control structures, kiosks and signs, and other items displayed in Table 3.10 below. All of these are important elements

that support our administrative, biological, visitor services and maintenance programs. In addition to the infrastructure, the Refuge has a long list of personal property assets, such as vehicles, boats, heavy equipment, computers, etc. that serve day-to-day Refuge operations. Currently, the Refuge has over 8 miles of dike roads, which form 13 wetland impoundments managed by 25 water control structures and two pump stations. In addition, the Refuge has 1.3 miles of paved road with several visitor parking lots. There are four buildings and a pole shed supporting maintenance operations and equipment storage. The headquarters/ Visitor Contact Station, environmental education center, fee booth, five trails, and various public access sites provide support to Refuge visitors. There are also four houses used for government quarters or storage.

Table 3.10. Refuge Infrastructure

	Tract No.	Year Built	Size
Levees, Dikes, Water Control Structures, Bulkheads			
Impoundment Dike Roads, Earth Fill / Gravel	Tract 39	Rehabilitated in 1992	7.2 miles
Colchester Impoundment Dike Roads and Parking Lot, Earth Fill	Tract 141	2002	1.4 miles
A-Pool Water Control Structures (3)	Tract 39	1970	A-Pool 215 acres
B-Pool Water Control Structures (2)	Tract 39	1970	B-Pool 100 acres
B-Storage Pool Water Control Structures (2)	Tract 39	1970	B-Storage Pool 13 acres
C-Pool Water Control Structures (2)	Tract 39	1970	C-Pool 190 acres
C-Storage Pool Water Control Structures (2)	Tract 39	1970	C-Storage Pool 45 acres
C-Storage Pool Pump Station and Channel	Tract 39	1994 & 2000	12-15,000 gpm; 2,000 foot channel
D-Pool Water Control Structure (1)	Tract 39	1992	D-Pool 17 acres
E-Pool Water Control Structures (2)	Tract 39	1992	E-Pool 25 acres
G-Pool Water Control Structures (4)	Tract 39	1992	G-Pool 88 acres
H-Pool Water Control Structures (2)	Tract 39	1992	H-Pool 75 acres
J-Pool Water Control Structures (1)	Tract 39	1992	J-Pool 111 acres
Reforestation Site Water Control Structures (1)	Tract 125a	1994	
Frank Carter Impoundments Water Control Structures (4)	Tract 141	2000	Impoundments 26 acres
Bulkhead - Bay Shoreline at Headquarters	Tract 39	1941 Rehab. in 2007	200 feet
Rip-Rap Breakwall at Headquarters	Tract 39	2007	488 feet
Long Island Bulkhead	Tract 39	1978	1,000 feet

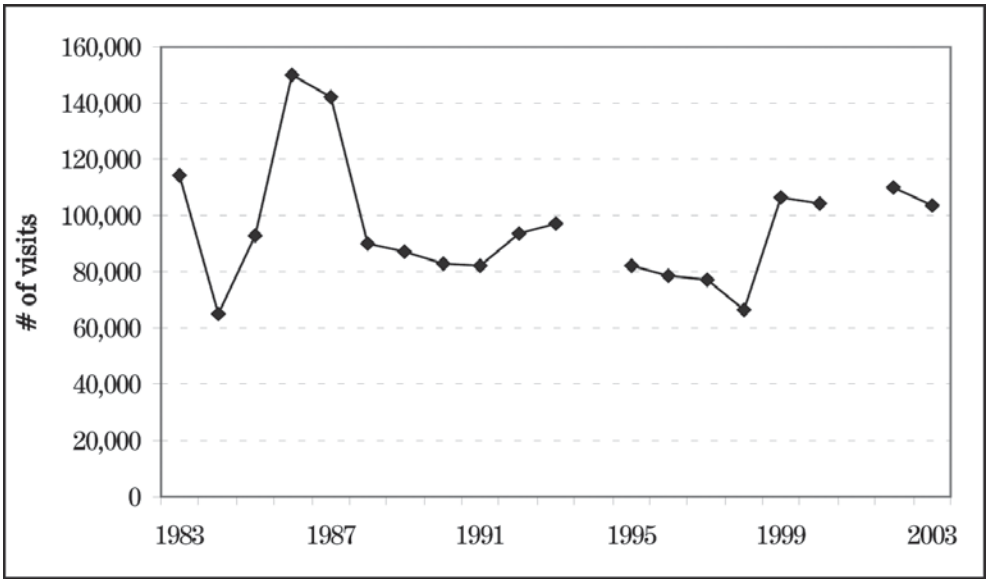
	Tract No.	Year Built	Size
Boat Launch Areas			
Headquarters Employee Boat Ramp and Public Fishing Dock	Tract 39	1941 Rehab in 2007	116 feet
Horn Point Canoe/Kayak Launch	Tract 174	2006	
Headquarters Canoe/Kayak Launch	Tract 39	1985	400 Sq. Ft.
Roads and Parking Areas			
Beach Access Ramp w- gate, Asphalt	Tract 39	2000	0.1 mile; 1 lane
Entrance Road w- gates, Asphalt	Tract 39	1967; gates - 1989	1.2 miles; 2 lane
Visitor Parking Lot, Asphalt	Tract 39	1985	37,697 Sq. Ft.
Horn Point Public Access Site, Entrance Road and Parking Lot, Gravel and Stone Pavers	Tract 174	2006	375 Ln. Feet and 5,625 Sq. Ft.
Reforestation Site Parking Lot, Gravel	Tract 125a	1994	1,200 Sq. Ft.
Colchester Impoundments Parking Area	Tract 141	2002	2,500 Sq. Ft.
Asheville Bridge Creek Environmental Education Center	Tract 151a	1972	
Buildings			
Headquarters/Visitor Contact Station	Tract 39	1985	4,370 Sq. Ft.
Brick Storage/Shop Building	Tract 39	1964	2,228 Sq. Ft.
West Side Maintenance Shop	Tract 151	2006	2,800 Sq. Ft.
Storage Building - Tram	Tract 39	1997	5,500 Sq. Ft.
Fee Booth	Tract 39	1988	64 Sq. Ft.
Asheville Bridge Creek Environ. Education Center	Tract 151a	1972	1,440 Sq. Ft.
Oil Shed	Tract 39	1989	800 Sq. Ft.
Pole Shed	Tract 39	2004	4,096 Sq. Ft.
Maintenance Shop - YACC	Tract 39	1979	2,560 Sq. Ft.
Restroom Facility (Horn Point Access Site)	Tract 39	2006	96 Sq. Ft.
Wildlife Observation Building and Restroom	Tract 39	2006	532 and 96 Sq. Ft.
Horn Point House Government Quarters	Tract 172	1981	2,772 Sq. Ft.
Colchester House Government Quarters	Tract 157	1950	588 Sq. Ft.
Lotus House Government Quarters	Tract 131	1975	1,350 Sq. Ft.
Price House Government Quarters	Tract 135	1973	3,550 Sq Ft.
Trails and Boardwalks			
Bay Trail w/ overlooks	Tract 39	1994	2,250 feet
Kuralt Trail w/ overlook	Tract 39	1998	500 feet
Seaside Trail	Tract 39	2002	900 feet
Dune Trail w/ overlook	Tract 39	2000	1,200 feet
Asheville Bridge Creek Environ. Education Ctr. Trail	Tract 151a	1998	700 feet

	Tract No.	Year Built	Size
Trails and Boardwalks (cont.)			
Outdoor Classroom – ABCEEC	Tract 151	1998	252 Sq. Ft.
Outdoor Classroom - Headquarters	Tract 39	2001	56 feet
D-Pool Fishing Platform	Tract 39	1999	88 feet
Colchester Overlook Platform	Tract 141	2002	432 Sq. Ft.
Information Kiosks			
Headquarters Parking Area	Tract 39	1992	
Kuralt Trail Trailhead	Tract 39	2001	
Bay Trail Trailhead	Tract 39	1993	
D-Pool	Tract 39	2006	
Horn Point Public Access Site	Tract 174	2006	
Asheville Bridge Creek Environmental Education Center	Tract 151a	2006	
Other			
Fire Weather Station	Tract 39	1994	
Directional/Informational Signs	Several		
Chemical Storage Building	Tract 39	2003	96 Sq. Ft.

Refuge Visits

Virginia Beach is a major summer tourist attraction and receives several million visitors per year. A portion of that tourist trade also visits Back Bay. Records going back to 1983 indicate a low of about 65,000 and a high of about 150,000 visits per year (Figure 3.23). Peak visitation in the mid-late eighties was followed by a gradual decline in visits due to the implementation of an entrance fee as well as under-reporting. Recent records indicate a range of 100,000 to 120,000 visits per year, which is a more accurate reflection of actual visits.

Figure 3.23. Annual visits to the Refuge



An electric tram and beach vehicle transportation system, operated by the Back Bay Restoration Foundation (BBRF), provides a two-hour visit to False Cape State Park via the Refuge from Little Island Park just north of Back Bay. The electric trams operate daily Memorial Day through Labor Day, with a reduced schedule the remainder of the year, and the beach vehicle operates November 1 through March 31. The electric tram began operations in 1997. The number of passengers who use the tram has fluctuated between 800 and 1400 in recent years (Table 3.11) (Admire, unpublished data, 2006).

Table 3.11 Visitor use of the tram system

Fiscal Year	Tram Passengers
2000	1623
2001	1685
2002	961
2003	880
2004	
2005	
2006	1324

The Back Bay visitor profile changes throughout the year. Spring visits include local school education, summer visits show an increase in out of town tourists, while the fall sees a shift back to local residents and anglers. Table 3.12 indicates average monthly tram riders for the past four years (Admire, unpublished data, 2000 to 2003).

Table 3.12. Average monthly tram riders

Month	Average Passengers
April	91
May	177
June	201
July	333
August	321
September	139
October	73

White-tailed deer and feral hog hunting are permitted on the Refuge for seven days annually (starting on the first Saturday of October), when the State season opens. An application process is involved to obtain a hunting permit. Applications are usually available at the end of July and are due the first week of September. That process has evolved to a new State-run "Cyberdata" system currently.

Data for the annual Refuge hunt goes back to 1986, the first of the hunt and the peak harvest for deer and hunter use year; when a total of 366 hunters removed 147 deer (Table 3.13). Since then, there has been a general downward trend, except for in 2006 when harvest of both deer and hogs more than doubled from 2005 numbers. During the current seven day Refuge hunting season, a maximum of 62 hunters per day are permitted in the eight hunting units.

Table 3.13. Hunt Harvest Summary, 1986-2006.

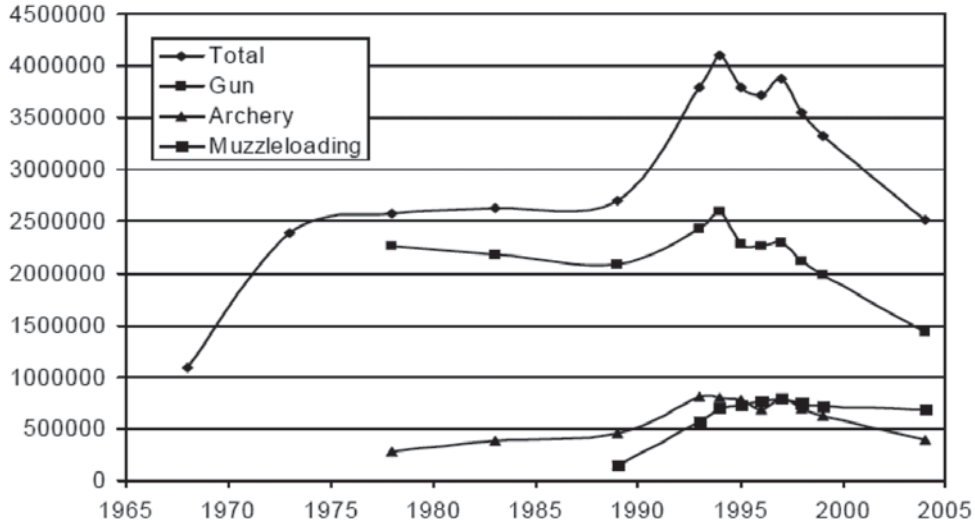
Year	Bucks	Does	Total Deer	Total Hogs
1986	41	106	147	11
1987	25	48	73	6
1988	20	40	60	10
1989	23	15	38	6
1990	15	15	30	1
1991	15	39	54	14
1992	24	24	48	9
1993	16	23	39	19
1994	29	27	56	22
1995	22	24	46	17
1996	25	34	59	38
1997	19	14	33	8
1998	15	16	31	39
1999	16	24	40	21
2000	32	17	49	35
2001	15	17	32	28
2002	8	11	19	37
2003	13	8	21	49
2004	7	10	17	44
2005	7	9	16	26
2006	19	14	33	64

Recreation

Hunting

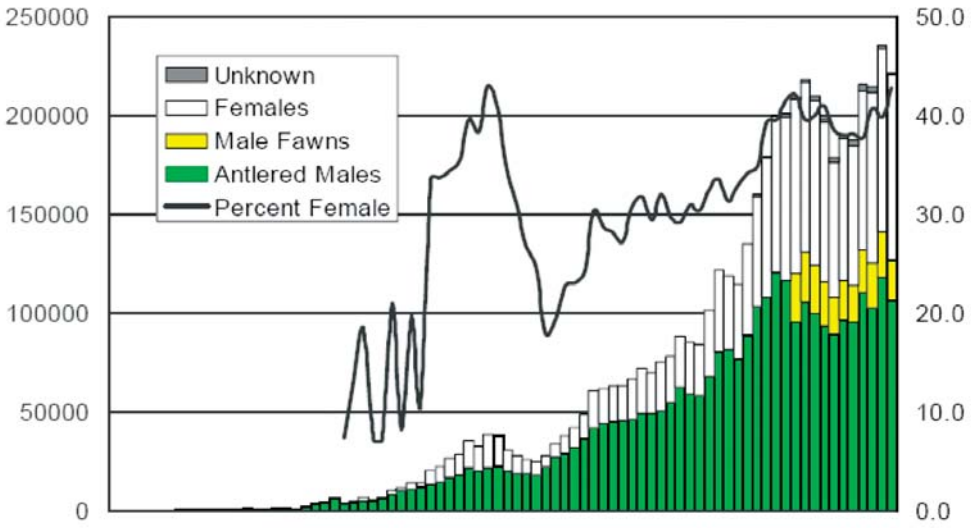
White-tailed deer are the most popular game species in the Commonwealth of Virginia. According to the 2004 to 2005 hunter survey, Virginia deer hunters spent approximately 2.5 million days afield in pursuit of deer. This total includes nearly 1.4 million general firearms hunting days, nearly 395,000 archery hunting days, and over 681,000 muzzleloader hunting days (Figure 3.24). According to 2004 to 2005 license data, there are approximately 240,000 deer hunters in Virginia. During the 2005 to 2006 deer season, 214,675 deer were reportedly harvested in Virginia (VDGIF 2006a). See Figure 2.25 for the number of deer harvested in Virginia Beach between 1923 and 2004.

Figure 3.24. Virginia deer hunter days afield, from hunter surveys, 1968-2005 (Source: VDGIF 2006a)



As a component of the general statewide population, total hunter numbers and their relative representation in Virginia's demographic profile also are decreasing. Individuals must apply to obtain a hunting permit. Over the past decade, the number of Virginia residents who purchase a basic state hunting license has declined 17%. As a percentage of the total population, licensed hunters have declined 26% over the last 10 years (VDGIF 2006a).

Figure 3.25. Virginia deer harvest, 1923-2004 (Source: VDGIF 2006a)



Archery Either-Sex Deer Hunting (VDGIF 2006b)

- Deer of either sex may be taken during all archery seasons, unless otherwise noted below

- Only antlered (buck) deer may be taken during the early and late archery deer seasons in Buchanan County, on private lands in Dickenson County, and on private lands in Wise County. Deer of either sex may be taken during the archery deer seasons on public lands (National Forest and U.S. Corp of Engineer) in Dickenson County and Wise County.

  Early Archery Season:
  October 1-November 18: Statewide

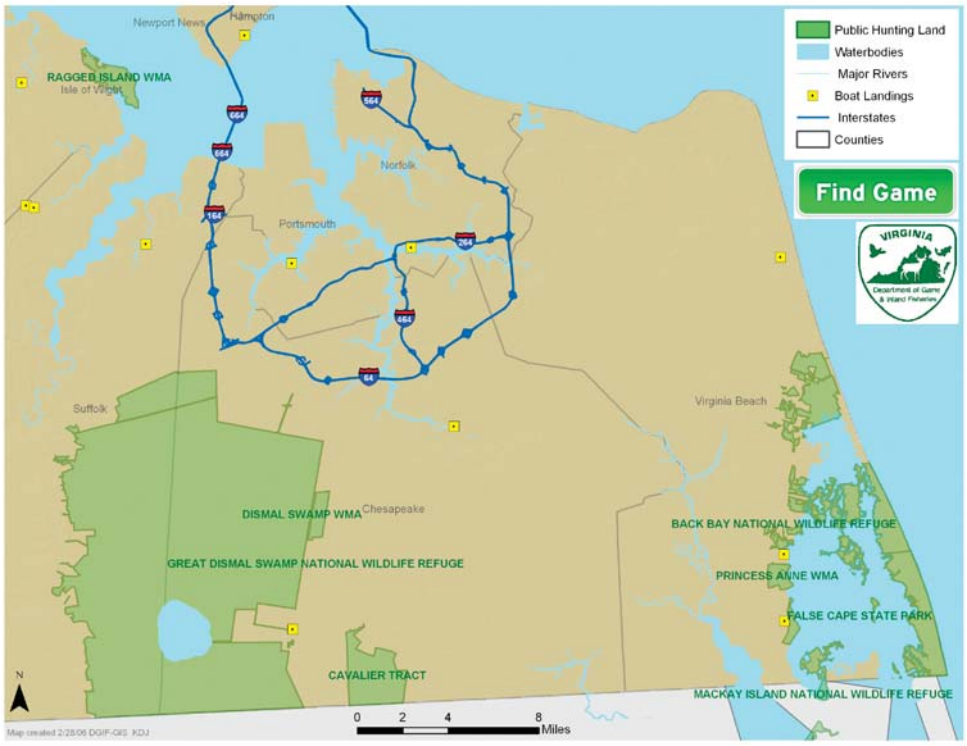
  Late Archery Seasons:
  December 1–January 7:
  - In the cities of Chesapeake, Suffolk (east of the Dismal Swamp line), and Virginia Beach.

Firearms Either-sex Deer Hunting For Incorporated Cities and Towns

- In the cities of Chesapeake, Suffolk (east of the Dismal Swamp line) and Virginia Beach:

  Either-sex Deer Hunting Days:
  November 24-30
  - In the cities of Chesapeake and Virginia Beach.

Figure 3.26. Deer Hunting Areas in the State of Virginia (Source: Jenkins, VDGIF, 2006)



Fishing
Within the City of Virginia Beach, Back Bay, Lake Whitehurst and Lake Trashmore provide the best fishing opportunities. With more than 25,000 acres, Back Bay is the largest body of water in the district. It produces good white perch and channel catfish at times, some flounder, and other saltwater and brackish water species. Many citation channel catfish are caught in the tributary creeks in the spring, as fish move into fresher water to spawn. The freshwater creeks feeding into the bay have largemouth bass, crappie, and bluegill. Bank fishing is limited and available only in some of the tributary creeks. Some fishing is available at the state-owned boat ramps on Mill Landing Road, Back Bay Landing Road, and some private ramps. Several private launch ramps are available on the bay and feeder creeks off Princess Anne and Muddy Creek Roads. The Refuge offers fishing in Back Bay, along the shoreline and from a fishing pier and boardwalk in front of the headquarters/visitor contact station; and, at the Horn Point Canoe/Kayak Launch. Fishing is also provided in D-Pool, a small impoundment a short walk from the visitor contact station. Saltwater, surf fishing is allowed along the beach (except the "North Mile").

Lake Trashmore offers fishing for largemouth bass, sunfish, and white perch. Lake Whitehurst has become a walleye hot spot, with many fish in the 4 to 6-pound range. It is one of the few lakes in the state where anglers have been able to catch walleyes with any consistency.

North Landing and Northwest Rivers also provide great fishing opportunities in the City of Virginia Beach area. Anglers will find a wide variety of fish in these waters, both freshwater and brackish. Common fish in the North Landing River include largemouth bass, bluegill, pumpkinseed, yellow perch, white perch, and white catfish. The Northwest River has fewer brackish water species than the North Landing River. White perch and white catfish are not as common, while Bluegill and pumpkinseed sunfish are abundant. The Northwest River also has some black crappie and chain pickerel (VDGIF 2006c).

Environmental Education
The Refuge has an active environmental education program, with the focus on providing on-site and off-site program delivery to elementary school children. Currently, more than 4,000 school children from more than 60 schools visit the Refuge annually. To a lesser degree, area middle schools, high schools and colleges also participate in environmental education programs and internship projects. Many other groups and organizations seek environmental education experiences on the Refuge, including community, church, youth and interest groups, as well as scouting organizations. The Refuge's web site is growing in popularity, serving as an additional means for individual environmental education experiences.

The trail system around the Refuge headquarters, an outdoor classroom, pond activity pier, the oceanfront, bay and impoundment areas all serve as environmental education resources for individuals and groups. A number of self-guided interpretive kiosks and panels are strategically located throughout the Refuge, with the highest concentration in the Refuge headquarters area. Attached to the Refuge headquarters is the Visitor Contact Station, which houses exhibits and educational publications, as well as audiovisual programs. On the Refuge's west side, a recently acquired 17 acre home site has been converted to the Ashville Bridge Creek Environmental Education Center. It consists of a 1,500 square foot home that has been converted to a classroom accommodating 40, a short nature trail, activity pier/canoe launch, outdoor classroom, and a resource library. An agreement with Mr. John Cromwell, the adjacent farm property owner, provides a cooperative environmental education opportunity

for groups to learn about ecologically compatible farming practices. The Back Bay Restoration Foundation assists Refuge staff in planning, organizing and conducting environmental education activities. The Refuge also partners with neighboring False Cape State Park and area interest groups, such as Audubon, Ducks Unlimited and The Izaak Walton League, in the delivery of environmental education programs and special events. The Refuge is also an active partner with The Virginia Beach school system in its Partners In Education program. Together with the help of its many partners the Refuge is able to offer a wide variety environmental education opportunities to its visitors.

Interpretation
The Refuge plans, organizes and delivers a wide variety of personal and non-personal service interpretive programs for the general public, using staff, volunteers, and interest group representatives. More than 5,000 visitors annually participate in formal interpretive programs offered by Refuge staff or partners. Thousands more take advantage of self-guided interpretive opportunities afforded by publications, exhibits in the Visitor Contact Station, trail-side signs, kiosks, and the Refuge's web site. Guided programs take place through tram, bicycling, "Terra-Gator" beach vehicle tours, talks, guided walks, demonstrations, and audiovisual presentations. A reference and interpretive publication library is available for students and teachers at the Ashville Bridge Creek Environmental Education Center (ABCEEC). As an urban interface Refuge, there is considerable demand for the Refuge to provide both on and off-site interpretive programs and facilities. The existing public area in the Visitor Contact Station has square footage to accommodate 30 people at one time for formal, indoor interpretive program delivery. The ABCEEC classroom facility can accommodate 40 people at one time.

Most programs take place at the Refuge headquarters area, at the Visitor Contact Station, on the beachfront, or at the ABCEEC. Monthly interpretive calendars are produced, with program schedules and descriptions. Most programs require advance registration and program groups are generally limited to 20 people. Due to the seasonal nature of visitation, most formal programs are delivered during the peak use months of April through September. The Refuge tram system, operating daily from April through October, provides a means of transporting visitors though the Refuge to False Cape State Park, and is a popular and valuable interpretive programming tool, with guided tram tours scheduled on a regular basis.

Wildlife Observation
A variety of structured, as well as unstructured, opportunities exist for wildlife observation on the Refuge. In addition to migratory waterfowl, there is the chance for visitors to observe several hundred species of songbirds, raptors, including bald eagle and osprey, red and gray fox, feral horses and hogs, white-tailed deer, and many other mammals, as well as reptiles, crustaceans fish. The Refuge's six different habitat types also present a wonderful opportunity for visitors to view wildlife in diverse landscape settings containing common and unique vegetation specific to each habitat type. Habitats include beach/dune grasslands, barrier island woodlands and shrub-scrub, fresh-water marshes, forested swamp, lowland forest and agricultural fields.

Visitors can participate in wildlife viewing opportunities in a self-guided manner, by special use permit for larger groups, by reservation for school groups, or by participating in guided, developed interpretive programs and activities for the general public. Tours are conducted on a scheduled basis by foot, bicycle or tram. Spring and fall are the best seasons for this type of activity, although the nature of tourism in the Virginia Beach area brings many visitors out to the Refuge to view wildlife in the summer months, as well.

Refuge resources that support wildlife viewing include self-guided interpretive kiosks, brochures and publications, outdoor classrooms, nature trails, observation piers, fixed viewing scopes, impoundment dike roads, the Refuge web site, interpretive staff and partners, a small Visitor Contact Station with audiovisual programs and exhibits, and the 17 acre Ashville Bridge Creek Environmental Education Center (ABCEEC) site, with associated classroom facility, nature trail and activity pier, and the Refuge's Reforestation Site. Water-born wildlife viewing is also possible from Back Bay and its watershed. A public canoe/kayak launch ramp at the Refuge headquarters, as well as several others surrounding Back Bay, help facilitate water-born wildlife viewing opportunity on the Refuge. Organized groups are afforded the opportunity to sign out binoculars, guide books, and other supplies and materials on loan that serve to enhance the wildlife viewing experience.

Much of the effort of Refuge staff in recent years is focused on attempting to transition some of the public use for wildlife viewing and other environmental education experiences from the Refuge headquarters area to the ABCEEC site, which was opened in October of 1999. There is considerable pressure, especially from interest groups, to access the Refuge impoundment area during the November through March closure, in order to take advantage of wildlife viewing opportunities during peak waterfowl migration season. Directing and controlling visitor use for this type of activity to safe and accessible open areas, while protecting closed areas, sensitive habitat, and protected species is also an ongoing effort and workload for Refuge staff.

Key Refuge partners, including the Virginia Department of Game and Inland Fisheries, the Virginia Eco-Tourism Association, the Back Bay Restoration Foundation, False Cape State Park, and the Virginia Beach and Cape Henry chapters of Audubon all help to promote wildlife viewing on the Refuge. The Virginia Coastal Birding and Wildlife Trail, a new major wildlife viewing project expected to be completed by 2005, includes the Refuge as a primary destination to those seeking high quality wildlife viewing opportunity in the Hampton Roads area. The demand for wildlife viewing opportunity, especially birding, and pressure for related support services and facilities is expected to grow dramatically throughout the decade.

Photography
The opportunity for nature photography on the Refuge is as varied as its wildlife and habitat types. Currently, this type of use is permitted in all open areas of the Refuge, and may be approved through special use permits where appropriate in other situations. Although relatively passive in nature, concerns with this type of activity include wildlife disturbance and the possibility of habitat degradation. Photographic use is not currently limited by regulation to existing roads, trails or other developed areas, such as viewing blinds. This type of use on the Refuge is, to a large degree, associated with wildlife viewing, so many of the resources and facilities necessary to support this activity are the same. Trails, activity/viewing piers, impoundments and associated dike roads, Back Bay and the Refuge's ocean beachfront all provide ideal backdrops for wildlife photography. Pressure to use the Refuge for commercial wildlife photography is minimal. Several interpretive programs are scheduled throughout the year that highlight and encourage nature photography on the Refuge. In addition to interpretation, other workloads generated by this type of use include monitoring, enforcement, and special use permitting.

Land Use

Prime Farmland
Cooperative farming has been permitted to occur on newly acquired lands that were farmed prior to acquisition since the early 1990s. Farming supports the local economy while maintaining the disturbed status of the land, in the event that a better use for it is determined. Agricultural farming is prevalent in the

surrounding community. At present, three cooperative farmers manage a total of 100.5 acres of Refuge farmland. Only corn and soybeans are grown on these lands and only approved pesticides and herbicides are permitted. Genetically modified crops are not permitted.

An exchange for services or annual fee system is often utilized for farmed crops. Services provided contribute significantly to habitat maintenance support within Refuge grasslands and moist soil units each year. The cooperative farmer's equipment and manpower are used to mow, disc, root-rake and apply herbicide to Refuge habitats; and saves additional costs to the Refuge to perform this work and/or contract it out. Cooperative farming provides many valuable habitat maintenance services that the Refuge could not otherwise afford.

Timber
Most Refuge forested habitats are not yet mature, and are principally lowland/bottomland types. As a result, their timber values are not very high. However, limited logging could be in accordance with good forest management practices aimed at restoring native tree diversity.

The barrier island portion, along the western side of A-Pool, includes a young remnant maritime forest. It includes such southern species as live oak and pond pine, together with the usual red maple, sweetgum and loblolly pine. Other lowland forests exist along the western side of Back Bay, in the Nanney Creek, Beggar's Bridge Creek, Muddy Creek and Hell Point Creek vicinities, and along the northern and southern sides of Sandbridge Road. They consist primarily of red maple, bald cypress, sweetgum, black gum/tupelo, white oak, laurel oak, southern magnolia and scattered loblolly pine. Waxmyrtle, high-bush blueberry, and groundsel shrubs are also scattered about the forest floor, together with several ferns, vines, canes and greenbriers. In several older growth locations, very large trees exist that should be protected and preserved.

During the late 1990's, RTNCF refuges' foresters and biologists visited RTNCF forested habitats, including the "Green Hills" area. They theorized that the remnant maritime forest along the western side of A-Pool may have formerly been a longleaf pine-live oak forest that was clear-cut, and replaced by the existing (red maple, sweetgum and loblolly pine) tree species.

A small 2 acre tract of planted Atlantic white cedars exists immediately south of Sandbridge Road. This entire 15-acre field (behind the cedar stand) was also planted to a variety of oaks, green ash and bald cypress in 1994 and 1995. The intent was to recreate a unique mixed bottomland hardwood-softwood forest as could have existed during pre-settlement times. The 2-acre white cedar concentration was fenced to prevent deer browsing. Subsequent monitoring of this "Wetlands Reforestation Site" revealed that nearly all oaks, cypress, white cedar and green ash planted outside the fenced area, were destroyed by deer-browsing during winters of the late 1990s. The previously planted areas outside of the fenced cedar stand, have succeeded naturally to loblolly pine, groundsel/saltbush, sweetgum and blackberry. The white cedars within the fenced area have survived, and natural regeneration has been observed since 2000. The cedar stand has been thinned annually to reduce competition for sunlight, by loblolly and groundsel/saltbush. However, progress has been force-account, and slow. Currently the eastern end of the stand contains a strip of tall loblolly pines (15') that are out-competing existing cedars.